

ROADS AND STREETS

JANUARY, 1941

TECHNOLOGY DEPT.

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DETROIT

State Route 118 in Jeff Davis County
—Davis Mountains in Background
(Courtesy—Texas Highway Department)

Tech.



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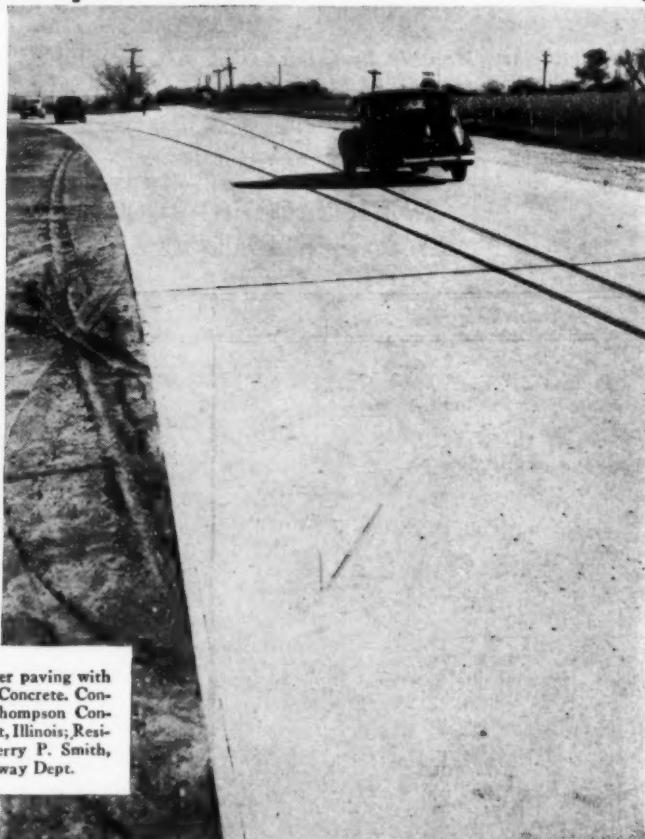


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ROADS and STREETS

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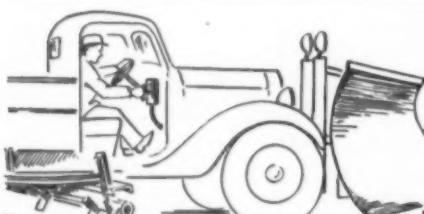
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JANUARY, 1941

No. 1

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ROADS and STREETS

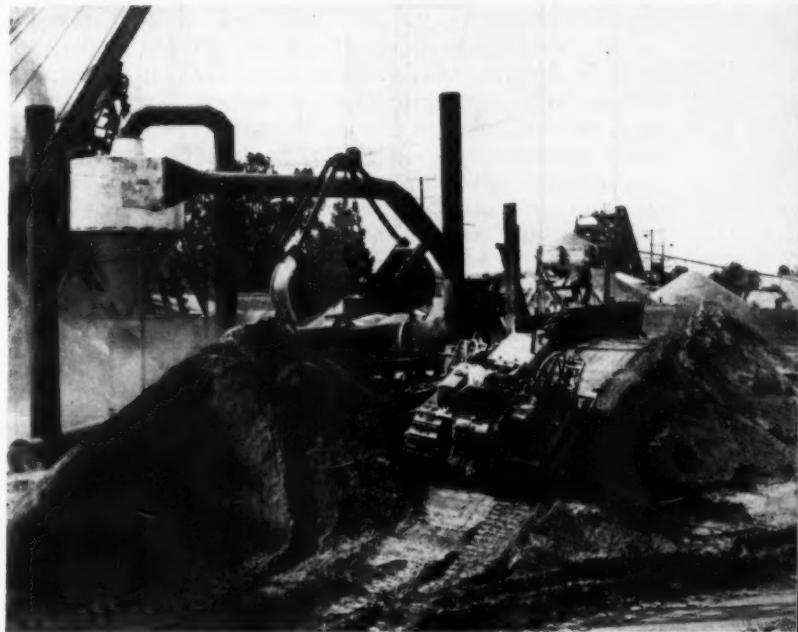
Vol. 84, No. 1

January, 1941

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MAINTENANCE PROCEDURES ADAPTABLE

*To Contract,
Day Labor, and
W.P.A. Management
Arrangements*



Where Equipment and Plant of This Character Are Required for Special Maintenance Work, the Contract Method May Be More Economically Employed. This Outfit Is Preparing Hot Asphaltic Mixture

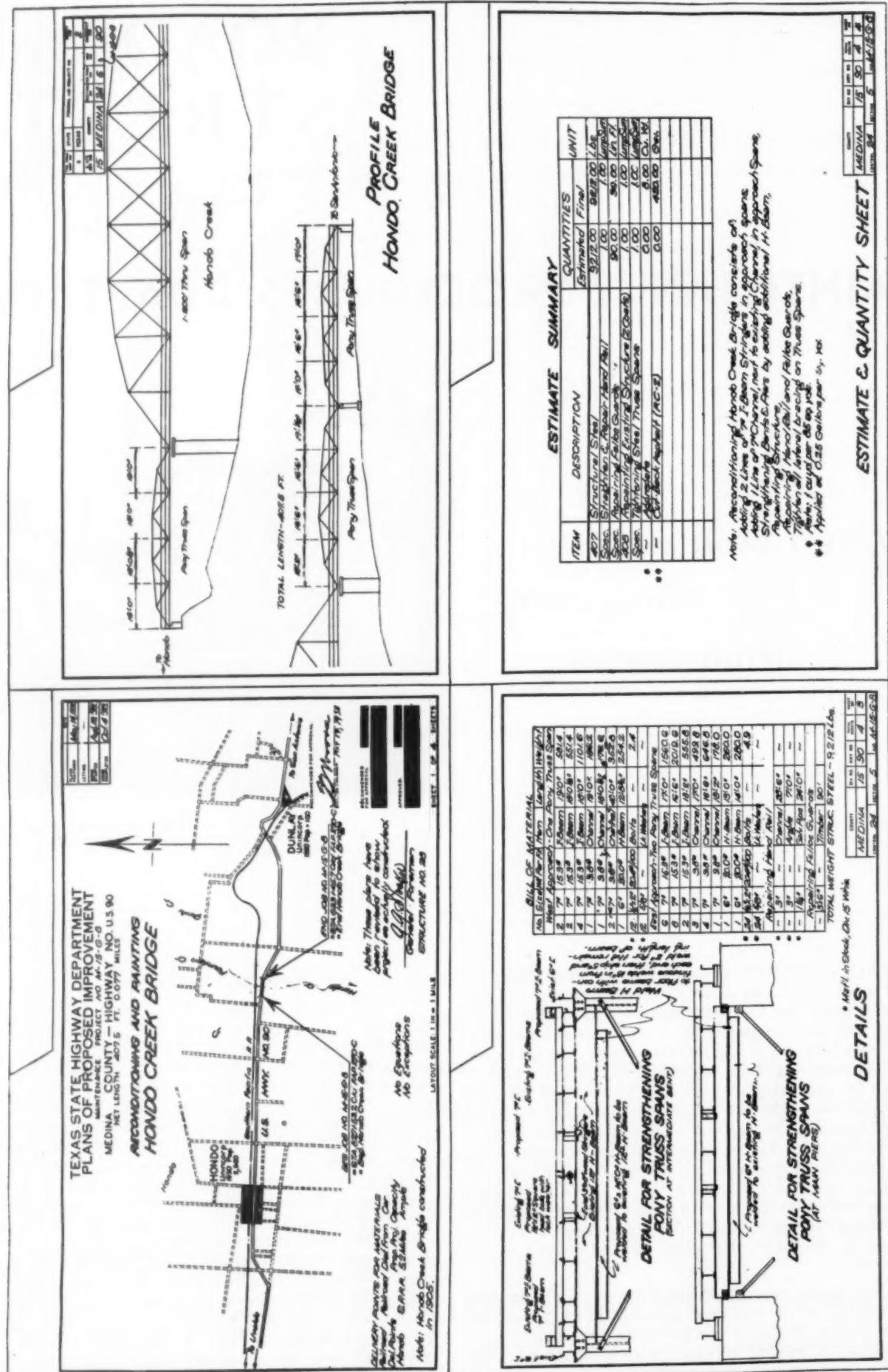
By M. B. HODGES
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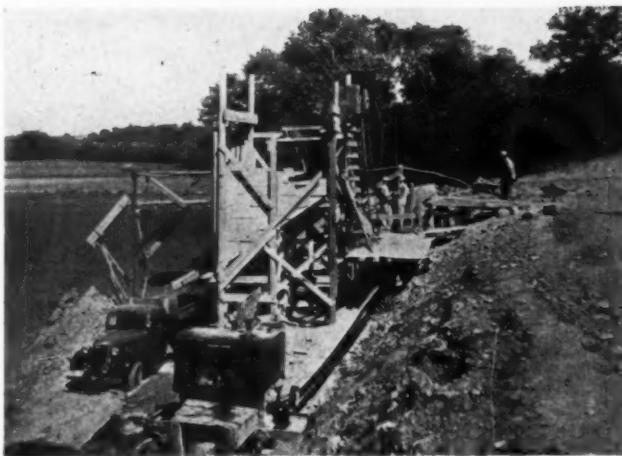
MAINTENANCE procedures as well as maintenance operations have received and are still receiving the careful attention of highway engineers who are charged with this ever increasing task. Every structure or facility requires maintenance as soon as the construction phase is completed. This is as inevitable as the proverbial "Death and Taxes" and the year 1941 promises to be no exception. However, to admit that maintenance is necessary on a highway system is only the first step. The main problem lies in determining procedures to get this usually vast and diversified operation done economically. Since the writer's experience has been limited to this work within the Texas Highway Department, the procedures developed here are being reported in the hope that they may be found useful elsewhere.

A clear understanding of the type of work involved is necessary before considering methods of procedure. In the Texas Highway Department the maintenance operations are divided into two groups. These are Regular Maintenance and Special Maintenance.

The first type consists of that work which is done regularly throughout the year by workmen directly under the supervision of a Section Foreman. The primary object of this work is to keep the facility in the same condition as constructed. Many highway departments, road districts, and other similar agencies have attempted the contracting of this operation at one time or another but, so far as we know, these experiments have not been successful. This is attributed to the fact that there is such great diversity of opinion as to what constitutes adequate maintenance. Naturally the contractor in these instances wants to hold his work to a minimum while the owner makes an effort to get complete repair of all deterioration. This lack of agreement leads to the conclusion that the most satisfactory method of getting this type of work done is by day labor forces employed by the agency owning or controlling the highway. This is the method used most extensively and we see no indication that a change is probable.

Regular Maintenance





This quarry operation near St. Joseph, Mo., in which a power unit drives a hammermill turning out 16 to 20 cu. yds. of crushed rock per hr. in sizes from 1½ in. down to dust, is an example of a type of maintenance work on which the W.P.A. arrangement can function effectively

Special Maintenance

The scope of the regular maintenance operation above described is the ideal that cannot be attained practically, therefore, we resort to special maintenance at such intervals as are necessary to restore the highway to its original condition. This operation is intended to make a periodic restoration of the damage which is the difference between that caused by wear and tear under traffic and the damage repaired in the course of the regular maintenance operation and also to repair damage caused by fires, floods, or other catastrophic conditions.

Our observation has shown that there has been an increasing tendency to minimize engineering in the field of highway maintenance. Apparently this is due to the fact that some of the men engaged in this work have such limited conception of engineering that they consider one of the component parts such as surveying, structural analysis, or road design as the whole rather than the part. However, we believe that engineering is management in the broadest sense of the term and that nowhere is there greater opportunity for, or a greater challenge to management than in the field of maintenance. An adequate knowledge of construction problems is necessary for intelligent planning of the special maintenance projects. We have found that these special maintenance jobs are really small construction projects, the results are improved by adequate engineering inspection and supervision.

Administrative Procedure

Our original procedure began with a request that all district engineers submit a list of proposed projects for their respective districts. These programs were considered by the maintenance engineer and those jobs which seemed to merit priority because of traffic service or protection of investment were selected, subject to the concurrence of the district engineers. The list of selected projects formed a Special Maintenance Program which was submitted to the state highway engineer and commission for approval. Significantly, no appropriations were requested at this time. The commission's approval was obtained as an authority to develop the jobs, and as an assurance that the necessary funds would be appropriated when investigation and planning had established the basis for a reasonably accurate estimate.

This procedure represents an evolution that has not yet become static. Recently this department has adopted

a slight modification in the initial phase by eliminating the programming. Instead, a special fund which is approximately ten per cent of the annual maintenance appropriation in each district is set up at the beginning of the fiscal year. Special maintenance projects proposed by the district engineers are financed from this fund on the recommendation of the maintenance engineer and with the approval of the state highway engineer. This reduces the amount of work involving specific approval by the highway commission and provides the district engineer with definite information on funds available for his district.

After a project is authorized preliminary engineering investigation is made in the field and skeleton plans for each project are prepared in the district offices. These plans are sent to the main office for review and comment. The requisitions for all materials are submitted to the Purchasing Division where they are referred to the Maintenance Division for verification of the material specifications and correlation with the approved plans. This operation is first order business since any delay, in handling, results in a progressive slowdown and loss of efficiency throughout the organization. The requisitions are returned to the maintenance engineer for approval-to-purchase after the bids are received and tabulated. This keeps the administrative section of the division apprised of current material prices and also affords an opportunity to note prices for materials f.o.b. the job site in the project file. These actual prices are used in the preparation of the Revised Project Estimate which is the basis for the appropriation request. The work order is issued; the necessary accounting arrangements completed; and the materials which are purchased on a ninety-day option may have already been purchased and carried in the stock account until needed on the project.

The advantages of the original method are largely the same as our present procedure beyond the programming stage. It is our opinion that the importance of the planning phase cannot be overestimated. This includes the programming as well as the design and management of the project itself. The small and so-called "Minor Project" plans are not expensive but their preparation tends to establish the scope of the project to the satisfaction of both the field and administrative divisions before work is begun. The single tracing sheet, 24 in. by 36 in., is kept intact for ease of handling and filing, but prints are trimmed and folded to fit standard letter-file folders. (See accompanying reduction.) The review of plans by the main office is



Herewith a type of maintenance work most effectively handled by the "day labor" method. After ditches are cleaned out the excess dirt is moved away on Missouri Route 113. From 150 to 200 loads, average 2 to 2½ cu. yds., are thus handled in a 9-hr. day

largely for the purpose of offering comments that give the district offices the benefit of both the good and the unsatisfactory experiences on similar work in other districts as reported to this clearing-house. The purchasing procedure gives both divisions of the organization actual, rather than estimated prices. It also permits the comparison of the cost of placing materials of the same kind in the various districts and this is the only part of unit costs that is comparable. More accurate estimating and financing is a direct result. This permits design for the project instead of for the available funds. This planning enables us to use the most economical of a variety of construction methods which would not be possible otherwise, and when the project is completed, the plans are revised to show the project as actually constructed. Our experience has shown that these final plans have more than justified their expense by their usefulness in maintaining an accurate road-log and in supplying the road life studies and State Planning Survey with needed data.

Special Maintenance Methods

Since special maintenance projects are adaptable to rigid specification and field control, a number of construction procedures can be used successfully depending on the specific type of work. Some of the methods used are described in the following paragraphs.

Contract Maintenance.—Several special forms of the contract procedure have been evolved to fit specific types of projects. The types of work usually handled as regular contracts are: river bank protection work near structures, sand blasting and painting structural steel bridges, and asphaltic seal coat work. The number of these jobs is not sufficient to justify the maintenance of a construction organization of semi-skilled workmen within the department and they are usually of sufficient size to interest specialized contractors. The bridge painting contract is the only one of these which is unusual since it is not possible for a government agency to specify a particular brand of paint to the exclusion of all others. We have attained the desired net result by purchasing large quantities of excellent paint for regular maintenance use and furnishing this material to the contractor at a price specified in the proposal. This procedure enables us to get the specific grade of paint desired; and it assures the contractor that material will be available when it is required.

A second type of contract which has not been used



Representative of regular maintenance" activities is this scarring and leveling job on U. S. 160 near Lamar, Mo. Preparing a smooth riding surface which may be primed, if desired, in preparation for receiving an oil mat surface

but which may be found desirable in the future is the management contract. It is a fundamental principle of our economic system that the tendency toward more efficient work continues as long as the compensation increases with the expenditure of effort. It is our opinion that since the compensation of the men who are employed to supervise day labor projects is fixed, these men have no continued incentive to increase their efficiency. As a result, although the individual losses from this lack of efficiency are generally small, they amount to a considerable sum due to the large number of repetitions of the occurrence. The suggested procedure proposes that the contractor will furnish the supervision necessary to get the work done according to plans and specifications, while the owner will furnish all materials and equipment and pay all labor. It is believed that such an arrangement would enable competent construction men, who are without capital, to manage state projects to the advantage of both parties. The apparent advantages are: elimination of cost of moving equipment in, utilization of the state's volume purchasing power, and the elimination of the necessity for social security and workmen's compensation insurance bookkeeping and reports which now increase the contractor's overhead. It should be understood that this is an untried method of getting more efficient supervision and greater economy on small projects which are classed as special maintenance. It may have disadvantages which outweigh its apparent advantages, but its further discussion and possible experimental use may have some merit.

The contract involving the use of WPA labor has been used successfully to further the work relief program of the federal government and at the same time conserve the state highway dollar. The essentials of this agreement are that the contractor will provide all necessary equipment and materials except that which is specified in the WPA proposal. He will also furnish adequate supervision for the relief labor assigned to his project by the local WPA office. This labor is furnished without cost to the contractor but he is not required to use men who lack skill or a desire to work. Details are available upon request.



Shown here is a type of maintenance work in which a "force account" or "cost plus" arrangement works effectively. A 12 ft., 400 gal., distributor is spreading a prime coat of SC-2 road oil on an earth grade on Missouri Route 6 near Clarksdale. This is the first step in a light surface treatment job to widen the adjacent 9-ft. concrete slab

Day Labor Maintenance.—Day labor construction in conjunction with the WPA has been especially valuable to the Texas Highway Department. This procedure has the advantage of being quite flexible, since it is generally possible to correlate the operation of these projects with the supply of relief labor available. However, these projects have the disadvantage inherent in all day labor work which is the possible lack of vigorous

supervision. While the state highway department must not be considered a social welfare organization and must make its work in conjunction with the WPA financially sound, the cooperation has brought home the realization that unskilled relief labor is a local commodity which must be utilized in constructing and maintaining our highways. The effective use of this labor has been a challenge to the ingenuity of our field supervisory forces in this machine age and the results obtained are proof that the engineer can play a leading role in the solution of social problems since the failure of work relief projects to reflect an improvement commensurate with the cost can, in most instances, be attributed to lack of competent leadership.

Day labor projects handled exclusively by state forces are the last type to be considered. These jobs frequently must be built while traffic continues to use the highway. This flexibility of operation under unpredictable conditions is an intangible advantage but it is frequently the determining factor. The department has enough work of this type to give constant employment to one or more small construction organizations in each district and the result has been the development of an increasingly efficient personnel. Unit prices have remained comparable to those on the same items on the smaller contract projects. Continuous comparison gives a regular check on the economy of day labor operations.

Conclusion

The procedures summarized have been employed successfully where the characteristics of the job coincided with the advantages of the particular method used. However, these procedures must not be considered fixed. An objective attitude must be maintained if we are to see the shortcomings of our present methods and to continue to improve them.

REGULAR FEDERAL-AID FUNDS AUTHORIZED FOR 1942 AND 1943

The Federal Highway Act of 1940, which authorizes regular Federal-aid funds for highways, secondary or feeder roads, and grade crossings for the fiscal years 1942 and 1943, was approved on September 5, 1940. The act is in conformity with the congressional policy of authorizing in advance of the period for which they are available the Federal-aid funds for 2 years, enabling the various State legislatures, many of which meet biennially, to plan their highway budgets with foreknowledge of their approximate Federal-aid apportionments. Federal funds for other classes of road work are also provided by the act, the amounts provided for each fiscal year being as follows:

Item	Amount for each fiscal year
Federal-aid system	\$100,000,000
Secondary or feeder roads	17,500,000
Elimination of hazards at grade crossings	20,000,000
National forest highways	7,000,000
National forest development roads	3,000,000
National park roads	4,000,000
Parkways	7,500,000
Public land roads	1,500,000
Indian roads	3,000,000

As in previous years, the Federal-aid highway and secondary road funds must be matched with State funds, and the grade crossing funds are outright grants to the States. Funds for these three classes of work apportioned to the States, the District of Columbia, Hawaii, and Puerto Rico, by the Federal Works Administrator. Formulas for apportioning the funds among the States remain unchanged.

Section 12 of the act specifically authorizes the Reconstruction Finance Corporation "to cooperate with States to finance, or to aid in financing the acquisition of real property or interests in property * * * necessary or desirable for road projects eligible for Federal aid under the Federal Highway Act * * *." This provision will enable the long-term financing of highway rights-of-way through cities, thereby facilitating the early completion of necessary improvements that heretofore have not been undertaken because of the lack of sufficient current funds to pay both right-of-way and construction costs. High right-of-way costs, in many cases amounting to several times the actual construction costs, have retarded improvements to main routes through cities needed to eliminate traffic congestion and attendant danger and delay.

Section 19 of the act provides that: "In approving Federal-aid highway projects to be carried out with any unobligated funds apportioned in any State, the Commissioner of Public Roads may give priority of approval to, and expedite the construction of, projects that are recommended by the appropriate Federal defense agency as important to the national defense."

Under this provision of the law it should be possible to make an immediate beginning on the strategic highway program. A system of 75,000 miles of main highways has been selected by military and naval authorities as highly important for definite strategic reasons. Many sections of the system are already in satisfactory condition but there are also numerous substandard sections. Replacing weak bridges and widening and strengthening road surfaces and shoulders will be important parts of the work. The program is aimed at the elimination of critical weaknesses and restrictions on main highways.—*From Public Roads*.

TRAINING ENGINEERS FOR DEFENSE

Dean S. C. Hollister of the College of Engineering, Cornell University, has been appointed regional adviser for the state of New York outside New York City on the new national program for Engineering Defense Training. Congress recently appropriated \$9,000,000 for special engineering courses at the college level, to be given at Government expense. The objective is to train 30,000 students with technical backgrounds to meet future needs of both industry and government in carrying out the defense program. The educational program will provide full time, part time, and evening classes.

OHIO CONTINUES MONDAY POLICY

Because of the necessity for uninterrupted time for the transaction of departmental business, the policy heretofore in effect of reserving Monday each week will again be made effective January 1st, Hal G. Sours, director of the Ohio department of highways, has announced. This program, Mr. Sours said, "should react beneficially in the interest of representatives of firms having business with the highway department, and in the best interest of the public." The policy will affect all business in the offices of the director, chief engineer, bureau heads and others within the department.

REVIEW OF TAR ROAD CONSTRUCTION IN 1940

A Summary of Standard Practices and Developments

By A. R. TAYLOR

Consulting Engineer, Tarmac Department
Koppers Company, Pittsburgh, Pa.

TAR ROAD construction in 1940 showed improvement in many construction practices, as well as improvement in uniformity in tar specifications.

The tar specifications most generally used during the past were those of the American Association of State Highway Officials. While other specifications were used, they varied for the most part in minor details from those of the A.A.S.H.O. The specifications of the A.A.S.H.O., recently adopted by the Federal Specification Board, are given in Table I.

Some few Atlantic Coast States, in a desire to better control the use of certain crude tars and to assure more uniform results, used special specifications for tar grades RT-1 to RT-6. These specifications varied from the A.A.S.H.O. specifications in that they called for (1) a



Road Widened With Tar Stabilized Shoulders

higher minimum specific gravity limit, (2) maximum and minimum distillation limits, and (3) sulfonation factor limits for those fractions of distillate up to 300° C. and 355° C.



Construction of Tar Stabilized Shoulders

Subgrades

More attention is being paid to the design of the subgrade than in the past. This assures higher bearing power of the subgrade, thus permitting the use of lighter bases and eliminating the expense of building thicker and more costly types of pavement to help overcome poor subgrade conditions. Improvement in the subgrade may be accomplished in various ways, such as (1) greater care in the selection of the soil to be used for the subgrade, (2) when the subgrade consists of a clay soil, by adding and mixing sand, screenings, and other material to improve its bearing power, (3) by the addition of a "lift," or layer, of soil added to the subgrade in depths up to 15 in. or more, and (4) by stabilizing the soil with tar.

TABLE I.
AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS' STANDARD SPECIFICATIONS FOR TAR

GRADES	RT-1	RT-2	RT-3	RT-4	RT-5	RT-6	RT-7	RT-8	RT-9	RT-10	RT-11	RT-12	RTCB-5	RTCB-6
Consistency														
Engler Sp. Visc. at 40°C.	5-8	8-13	13-22	22-35										
Engler Sp. Visc. at 50°C.					17-26	26-40								
Float test at 32°C.							50-80	80-120	120-200					
Float test at 50°C.										75-100	100-150	150-220		
Sp. Gravity at 25°/26°C.	1.08+	1.08+	1.09+	1.09+	1.10+	1.10+	1.12+	1.14+	1.14+	1.15+	1.16+	1.16+	1.09+	1.09+
Total bitumen, % by wt.	88+	88+	88+	88+	83+	83+	78+	78+	78+	75+	75+	75+	80+	80+
Water, % by volume	2.0-	2.0-	2.0-	2.0-	1.5-	1.5-	1.0-	0	0	0	0	0	1.0-	1.0-
Distillation, % by wt.														
To 170°C.	7.0-	7.0-	7.0-	5.0-	5.0-	5.0-	3.0-	1.0-	1.0-	1.0-	1.0-	1.0-	2.0-8.0	2.0-8.0
To 200°C.													5.0+	5.0+
To 235°C.													8.0-18.0	8.0-18.0
To 270°C.	35.0-	35.0-	30.0-	30.0-	25.0-	25.0-	20.0-	15.0-	15.0-	10.0-	10.0-	10.0-		
To 300°C.	45.0-	45.0-	40.0-	40.0-	35.0-	35.0-	30.0-	25.0-	25.0-	20.0-	20.0-	20.0-	35.0-	35.0-
Softening Point of Distillation Residue, °C.	35-60	35-60	35-60	35-60	35-65	35-65	35-65	35-65	35-65	40-70	40-70	40-70	40-70	40-70
Application Temp.	60 to 125°F.	80 to 150°F.	80 to 150°F.	80 to 150°F.	150 to 225°F.					175 to 250°F.			60 to 120°F.	



Drag Treatment Being Mixed With Maintainer

Soil Stabilization With Tar

When stabilizing soils containing a high percentage of 200-mesh material, or if this class of material is particularly active, it is advisable to add sand, screenings, gravel, or similar material to improve the quality of the soil to be stabilized. The admixture of aggregate not only reduces the quantity of tar required for stabiliza-

tar are easier to mix than heavier grades and should be used with soils containing a low moisture content or a high clay content. The normal amount of tar required for stabilization ranges from $\frac{1}{4}$ to $\frac{1}{2}$ gallon per sq. yd. per inch of depth. When more tar is required to properly stabilize the soil, it is usually more economical to add and mix aggregate with the soil. When less tar is required, there is a question about its value in such small quantities as a water-proofing medium.

The sheepsfoot roller has been most generally used for compaction, but if the soil contains any amount of large sized gravel, it may be found advisable to dispense with the sheepsfoot and use a pneumatic tired roller for compaction. When sandy soils are encountered, the sheepsfoot roller will compact only to within one to two inches of the top, so that final compaction is best accomplished with a pneumatic tired roller. In clay soils, this roller will compact to the surface, but the sheepsfoot marks on the surface must be removed by shaving the top with a blade grader, maintainer or other suitable equipment. The surface is then finally consolidated with a pneumatic tired roller, although in some cases a flat wheeled roller is used for final compaction. After compaction, the surface is given a tack coat of tar and covered with sand. While this tack coat will handle traffic satisfactorily for a period of a month or so, the stabilized base course requires an adequate wearing surface to handle permanent traffic requirements.

Probably one of the greatest mistakes made in soil stabilization work has been to construct a stabilized base course of too little depth. Unless very good drainage and subgrade conditions are encountered, it is not such a course to a compacted depth of less than 6 inches. It is unreasonable to expect that a 4 or 5-inch stabilized base course is adequate under conditions where a 6 or 8-inch stone or gravel base is considered necessary.



Light Surface Treatment Over Gravel Base

tion but also helps assure successful stabilization. The percentage of aggregate to be added should be predetermined by laboratory tests, as well as the grade and amount of tar to use and the amount of moisture required for mixing and compacting.

The tendency has been to add only sufficient water to assure proper dispersion and to compact the admixture at as low a moisture content as practical. Even though maximum density is not obtained at the time of construction, additional compaction will occur under traffic. This being the case, the mixture may be compacted when the moisture content is under the optimum for maximum density.

Some soils stabilized have fallen in the category of sand-clay or top soil, some of which have contained considerable gravel. Such soils can be mixed with tar without water, and when soil is of such a character, water should not be used unless it is absolutely necessary for proper dispersion of the tar. When water is added for mixing, care should be taken to see that the mixture is compacted at the lowest moisture content practical under the circumstances.

The grade of tar used for soil stabilization ranges from RT-3 to RT-6. Naturally the lighter grades of

conditions are encountered, it is not such a course to a compacted depth of less than 6 inches. It is unreasonable to expect that a 4 or 5-inch stabilized base course is adequate under conditions where a 6 or 8-inch stone or gravel base is considered necessary.



Road Mix Graded Aggregate Type



Power Shovel Used for Mixing Bank Gravel With Tar

Stabilized bases can be used economically and to advantage for widening old roads. The soil is bladed on to the old road surface and mixed with the tar, after which it is bladed back into the trench where it is compacted, tack coated, and sealed.

Wearing Surfaces

The type of tar wearing surface best suited for any particular road depends on several factors. The most important of these are the type of subgrade, aggregates available, type and depth of base course, traffic requirements, and the cost of construction. All wearing surface types, from light surface treatments up to the more expensive plant mixes, have proved successful under varying conditions. A discussion of current construction practices for the various wearing surface types follows.

Surface Treatments

There are any number of different types of surface treatment that have proved both satisfactory and economical under varying conditions. Surface treatments may consist of single to triple applications of tar. Some are covered with coarse aggregate, some with fine aggregate, and others with a combination of coarse and fine aggregate. Some treatments are dragged and rolled; others are not. Dragging in some cases is done with light broom drags to distribute the cover material evenly, while in other cases the drag is used to mix the aggregate and tar, and to build up and level uneven surfaces.

Light treatments consist of either single or double applications of tar. Grades RT-2 to RT-6 are used to protect the road surface from the abrasive action of traffic and to eliminate the dust nuisance. Such applications are usually covered with fine aggregate that is locally available. These treatments lend themselves admirably to broom dragging. Light treatments are well suited for treating bases of questionable strength. If the treatment fails, the surface may be scarified and mixed with the base material without much loss in investment. If it holds up satisfactorily, it may be built thicker by the addition of a more viscous grade of tar and coarse aggregate.

Heavier treatments should be used for surfacing stable macadam, gravel and similar bases. Under such condi-

tions the double or triple application treatment should be used. For the first application, a light tar, grades RT-2, 3, and 4, is used for priming the surface. The quantity of tar required depends on the condition of the base course. Open or loosely bound bases require a heavier application of tar prime than for a tightly bound base. The tar prime is generally applied at the rate of $\frac{1}{4}$ to $\frac{1}{2}$ gallon per sq. yd., and is not covered unless traffic has a tendency to pick it up, in which case it is covered with only sufficient aggregate to prevent picking up. Hot tar is used for the second application and is generally applied at the rate of 0.3 to 0.4 gallon per sq. yd. and covered with $\frac{1}{4}$ -in. to No. 8 aggregate. The use of hot tar for the second application permits the use of larger sized cover material, builds up the surface to a greater depth, and gives a resilient wearing surface that requires a minimum amount of maintenance. In addition, the hot tar sets up immediately, so that the aggregate is held firmly in place, resulting in a minimum inconvenience to traffic. In the past few years there has been an increased tendency to vary this treatment by adding a third application or seal coat of tar and cover material. The seal coat may be either hot or cold application tar, applied at a rate of 0.2 to 0.3 gallon per sq. yd. covered with fine aggregate such as $\frac{1}{8}$ -in. to No. 8 or No. 4 to No. 16 aggregate. The fine aggregate is used to fill the voids in the large sized aggregate spread previous to the seal coat. The addition of the seal coat gives a particularly tight, dense, and yet skid-resistant wearing surface. It is not unusual for such treatments to go four to six years before requiring a retreatment.

Drag surface treatments consist of 30 to 60 lb. of aggregate mixed with either heavy cold or hot application tar. These treatments are usually used for leveling old surfaces that have become uneven. Rough surfaces will ordinarily require a 50 to 60-lb. treatment. This type of treatment is usually given a light seal coat, con-



Finished Surface of Tar and Gravel Mixed With Power Shovel



Finished Surface of Tar Sand Mix

sisting of 0.2 to 0.25 gallon of tar and 10 to 15 lb. of No. 4 to No. 16 aggregate. Such treatments give not only a smooth riding surface but also a tight surface of uniform texture.

Road Mixes

Road mixes are used when traffic conditions are such that a thicker surface is desired than can be obtained by surface treatment, or when it is advisable to increase the bearing capacity of the base course without disturbing it. Such surfaces are usually constructed to depths of two to three inches. While these surfaces are somewhat more expensive to construct than surface treatments, they are particularly well adapted for leveling and reshaping old roads, building up the edges of high crowned roads, and for widening old roads. Extremely smooth riding surfaces can be obtained from this type of construction.

There are two main types of road mix—the coarse aggregate type and the graded aggregate type. In the coarse aggregate type the stability of the mix is dependent upon the interlocking action of the aggregate and the binder, whereas in the graded aggregate type the stability is obtained from the greater density of the mix. The coarse aggregate type requires thorough choking and sealing to obtain a tight texture surface, whereas the graded aggregate type only requires a light seal coat to give an exceptionally tight surface. In both the coarse and graded aggregate types, mixing may be done with blade graders and maintainers, traveling mixing plants, power shovels, or stationary plants located adjacent to the project. Some graded aggregate types of road mix are constructed with new aggregate, whereas in others the old road is scarified and the aggregate in the road is utilized for the mix.

When the aggregate has to be shipped in, or when traffic is such that particularly stable surface is desired, the coarse aggregate type of road mix is used. In this type of construction best results are obtained from the use of hot tar, grades RT-7, 8, or 9. During the regular construction season no difficulty will be experienced in mixing when using these grades of material. However, if the work is done in the early spring or late fall, when the temperature is low, grade RT-6 should be used. The most important item in the construction of this type of surface is that the mix be thoroughly choked with small aggregate. Usually $\frac{3}{8}$ -in. to No. 8 or No. 4 to No. 16 aggregate is best suited for choking, and in some cases it may even be advisable to use a coarse sand for this purpose. After thorough choking, a second application of tar is applied and covered with $\frac{3}{8}$ -in. to No. 8 or No. 4 to No. 16 aggregate and uniformly distributed on the surface by means of broom drags. After rolling,

the seal coat is applied and covered with $\frac{3}{8}$ -in. to No. 8 or No. 4 to No. 16 aggregate. This method of construction will give a tight surface that will not require a retreatment for several years.

When suitable bank gravel or similar aggregate is locally available at low cost, the graded aggregate type of road mix is more economical. As suitable gravel can often be obtained in banks at little cost, the main expense involved is digging it out of the gravel bank, loading in trucks, and hauling to the job. In this type of construction close attention must be paid to the gradation of aggregate and the grade and amount of tar used in the construction. While the gradation of gravel can vary considerably, nevertheless it should be uniformly graded from coarse to fine. Tar grades RT-6, 7, and 8 are mostly used for this class of work; and it has been found advisable to use the heaviest grades of tar that can be readily mixed with the aggregate. A 2-in. compacted surface will normally require from 1.0 to 1.2 gallons per sq. yd. for the mix and 0.2 to 0.3 gallon per sq. yd. for the seal coat. Unless the gravel has to be screened and graded, its cost is low, so that under the most favorable conditions its cost is little more than that for one of the heavier types of surface treatments.

Tar-Sand Mixes

Another type of road mix used in sandy sections of the country is the tar-sand mix. Such construction is sometimes referred to as soil stabilization, but actually it falls more in the classification of a road mix, as the tar is used to bind together the particles of sand, rather than to waterproof them as in stabilization.

Tar-sand mixes are used mainly for light traffic roads where the existing material is sand, and the drainage is good. In such construction it is advisable to use a well-graded coarse sand, but if such is not available, either coarser or smaller sized aggregate should be added in order to give a well-graded material. When the sand is predominately one size, and particularly when the sand particles are round, it is difficult to construct a firm, stable mix. If the sand is fine, the percentage of tar required is high, so that it is more economical to mix coarse sand with it. This not only reduces the amount of tar required, but also gives a more stable mixture. However, the grade of sand available and the cost involved should determine whether or not it is advisable to add aggregate.

Before starting such a project, samples of the sand should be analyzed for gradation, percent of silt, loam and clay, and to determine the stability of the proposed mixture. As a rule, the presence of loam and silt in

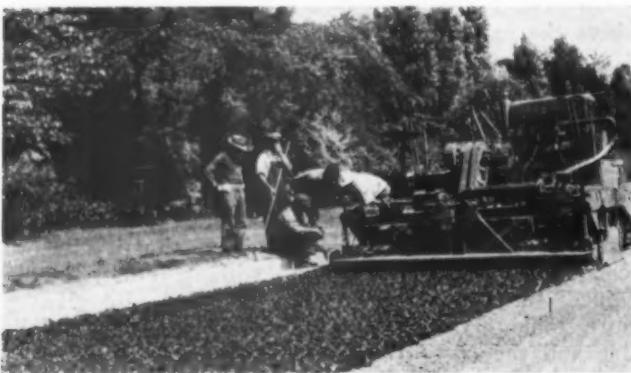


Spreading Stone for Bituminous Macadam Wearing Course

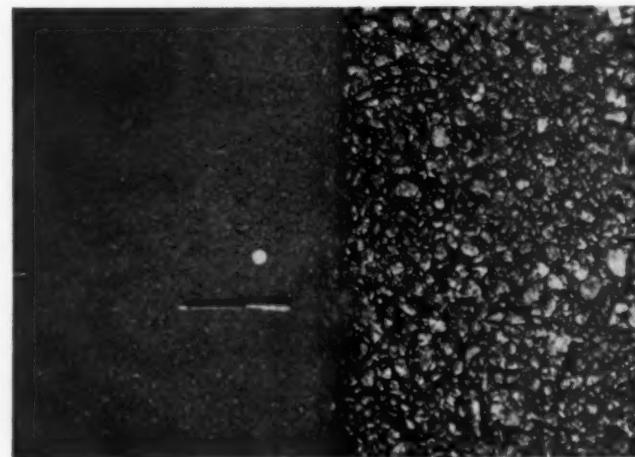
reasonable amounts aids the stability of the mixture, as it acts as a filler. A special grade of tar having a specific viscosity of 12 to 32 at 60 deg. C. is used for this type of construction. For a 6-in. compacted depth it usually requires from 2½ to 3½ gallons per sq. yd., applied in successive applications of 0.3 to 0.4 gallon per sq. yd., excepting for the last two or three applications, which are often applied at a rate not exceeding 0.15 gallon per sq. yd. After each application, the tar is mixed with the sand by means of disc harrows. After approximately 1¾ gallons of tar have been applied, the entire width of the road is plowed to obtain a uniform depth, and then mixing is continued with harrows. At this point, 3 to 4 in. of the mixture is bladed into windrows along the edges in order to expose the lower part for the better application and mixing of tar. The applications of tar are continued and mixed with harrows and blade graders until the required quantity of tar has been added.

Next the material in windrows along the edges of the road is bladed back over the mixture and again plowed to uniform depth. This is followed with light applications of tar, mixed to a depth of 3 or 4 in. with harrows and a maintainer until the total amount of tar has been added and a uniform mix is obtained. The surface is then shaped to proper contour, and after the mix has hardened sufficiently, it is rolled with a 5 or 6-ton tandem roller until a smooth and even surface is obtained.

Approximately one month after construction, or when the mix has set up hard and firm, it is given a seal coat of hot tar, and aggregate.



Spreading Binder Course of Hot-Lay Tar Concrete



Showing Surface Texture of Both Bottom and Top Course of Hot-Lay Tar Concrete

Bituminous Macadam

Bituminous macadam construction is used for both bases and wearing courses for depths of 2½ in. or more. Little equipment is needed for this type of construction. It is essential to see that the surface is properly choked and sealed since if the penetration course is not properly choked, there will be a tendency for the tar in the seal coat to penetrate to the bottom of the wearing course. The excess tar may flow to the edges, and, if so, the edges of the road may become flooded and bleed. If this condition occurs, it is due to improper construction methods.

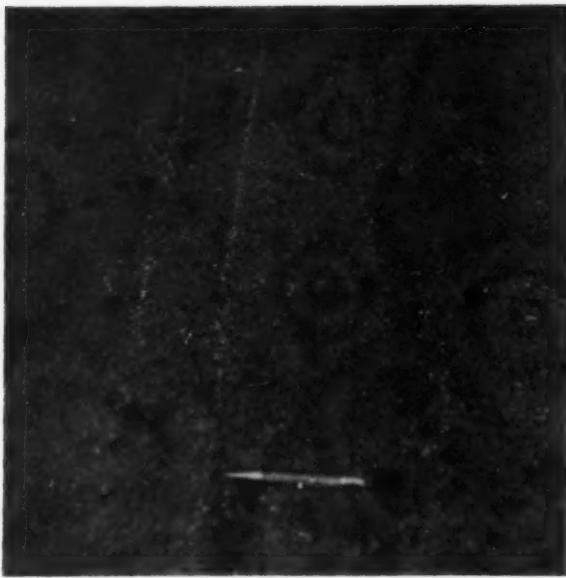
In bituminous macadam construction, tar grade RT-12 is applied in three applications. The first application for a 2½-in. penetration course is applied at the rate of 1½ gallons per sq. yd. This application of tar is covered with ½-in. to No. 8 or ¾-in. to No. 8 aggregate in sufficient quantity to fill in the voids. The aggregate is broomed over the surface to insure uniform choking and is then rolled. The second application of tar is then applied at the rate of 0.4 to 0.6 gallon per sq. yd. and is covered with ¾-in. to No. 8 aggregate. The aggregate is broomed evenly over the surface and rolled, after which all excess aggregate is swept from the surface. The seal coat of tar, 0.4 to 0.6 gallon per sq. yd. is applied and covered with ¾-in. to No. 8 or

TABLE II.
COMPOSITION OF MIXTURES AND GRADING OF AGGREGATE FOR PRE-MIX TAR SURFACES

COMPOSITION OF MIXTURE	Cold Lay Tar Concrete				Hot Lay Tar Concrete			
	Bottom Course		Top Course		Bottom Course		Top Course	
	Stone	Slag	Stone	Slag	Stone	Slag	Stone	Slag
Tar, Grade	RT-8, 9 or 10		RT-8, 9 or 10		RT-11 or 12		RT-10, 11 or 12	
Tar, % by weight	3.0-5.0	4.0-6.0	5.5-7.5	7.0-9.5	3.0-5.0	4.0-6.0	6.5-8.5	7.5-10.0
Mineral Aggregate, % by weight	95.0-97.0	94.0-96.00	92.5-94.5	90.5-93.0	95.0-97.0	94.0-90.0	91.5-92.5	90.0-92.0

GRADING OF AGGREGATE

Sieve Size	Percent Passing	Percent Passing	Percent Passing	Percent Passing
1½"	100		100	
1"	70 — 100		70 — 100	
½"	20 — 60	100	20 — 60	100
¾"	—	85 — 100	—	85 — 100
No. 4	5 — 20	50 — 75	5 — 20	55 — 80
No. 8	0 — 5	30 — 55	0 — 5	40 — 65
No. 20	—	10 — 30	—	—
No. 40	—	—	—	14 — 34
No. 100	—	—	—	6 — 20
No. 200	—	0 — 8	—	5 — 15



Tight, Dense Tar Surface Still Skid-Resistant After Three Years of Service

No. 4 to No. 16 sized aggregate and rolled. This method of construction will give a tight granular surface.

Pre-Mixes

Pre-mix construction, while more expensive than road mix construction, offers certain advantages. The gradation of aggregate in the mix can be more closely controlled, more uniform mixes are obtained, heavier grades of binder are used, and long delays occasioned by wet aggregates are greatly reduced as the aggregate is passed through a dryer and heated to the proper temperature. These types of pavement are particularly well adapted for resurfacing and widening old roads, as such construction does not necessitate closing the road and, if open to traffic, causes less interference with traffic than many other types of construction.

The two classes of tar pre-mix in use are cold-lay tar concrete and hot-lay tar concrete. The cold-lay tar concrete is mixed at a temperature not exceeding 115 deg. F. whereas the hot-lay tar concrete is mixed at a temperature between 150 deg. and 250 deg. F. and is spread at a temperature of 150 deg. to 225 deg. F. A more viscous binder and a denser graded aggregate is used in the hot-lay tar concrete. Due to the greater density of the hot tar concrete, a seal coat is not required, whereas in the case of most cold-lay bituminous concretes a light seal coat greatly increases the length of service of the pavement.

These types of surfacing are usually constructed in two courses to a total compacted depth of 2 to 3 in. Composition of the mixture and gradation of the aggregate for these classes of pavement are given in Table II.

These mixes are generally laid by mechanical spreaders, although hand spreading is satisfactory for small jobs or when no mechanical spreader is available. However, hand spreading results in greater segregation of the aggregate than is the case with machine spreading. Rolling is an important item in this type of construction, as it is necessary to compact these mixes at the right time and in proper amount if maximum density is to be obtained.

Skid Resistance

In tar construction tight, dense surfaces can be built without danger of their becoming slippery at a later date. In fact, many old bituminous surfaces that have

become slippery are treated with tar to overcome this condition. Such surfaces are usually treated with hot tar in applications ranging from 0.2 to 0.35 gallon per sq. yd., depending on the condition of the road surface and the amount and kind of traffic using the road. The general practice is to cover the hot tar with $\frac{3}{8}$ in. to No. 8 aggregate, although in those cases where the old surface has flushed considerably, larger sized aggregate is used. The amount of cover required varies from 15 to 30 lb. per sq. yd. After the aggregate is rolled into place, it is sometimes found advisable to use a light broom drag to distribute the loose material evenly over the surface, and again roll it. Such treatments have proved very effective for eliminating slippery surfaces.

Seal Coats

In the past year or two, more attention has been paid to seal coats than heretofore. The trend has been toward their application in such a manner as to give uniform light colored surfaces. In the past, seal coats were applied with varying quantities and grades of tar and covered with any available aggregate, regardless of its size and gradation. This unsatisfactory practice often resulted in excess flushing of the tar to the surface, causing a streaky appearing surface.

A uniform colored surface can be obtained by using hot tar and varying the rate of application according to the porosity of the surface to be treated and the size of aggregate used for cover material. A dark colored surface will be obtained when sealing with cold application tar.

A seal coat will only hold one layer of cover material, so naturally if small sized aggregate is used, the application of tar must be light if it is not to flush through the aggregate and cause streaking. It is erroneous to believe that the addition of a greater amount of aggregate will eliminate this condition, as only one layer of aggregate will roll into the surface. Any excess aggregate whips off the surface under traffic and the tar flushes through to the top.

When 0.25 gallon of tar is used for the seal coat, it should be covered with $\frac{3}{8}$ -in. to No. 8 aggregate, but if the quantity of tar is increased to 0.3 or 0.35 gallon per sq. yd., it should be covered with $\frac{1}{2}$ -in. to No. 8, or larger sized aggregate. A greater amount of the larger sized aggregate is required to cover the road surface one layer thick than is the case if smaller sized aggregate is used. Light seal coats of 0.2 to 0.25 gallon of tar should be covered with 20 to 25 lb. of $\frac{3}{8}$ -in. to No. 8 aggregate, whereas 0.3 to 0.35 gallon will require 30 to 35 lb. of the larger sized aggregate. Obviously the larger sized aggregate builds up a thicker seal coat than does the smaller sized aggregate.



Laying Tar Binder Course for Airport Runway



Runway After Application of Top Course Tar Concrete

Study of the surfaces to be sealed and proper selection of cover material according to the gradation and type of aggregate available will result in uniform appearing surfaces.

Airport Runways

Airport runways and taxi strips are not subject to the same traffic conditions as highways. While the loads may be just as heavy as those on a highway, the frequency of traffic is not comparable to that on a highway. In the case of runways and taxi strips, large and wide areas are involved so traffic seldom uses the same section of the pavement. As a result, the wearing surface does not get the ironing action of traffic to keep the pavement alive as in the case of a highway. To overcome the lack of traffic, a runway or taxi strip requires a richer wearing surface, but at the same time stability cannot be sacrificed due to the heavy loads using the runway. In addition, it is necessary to have a tight, water-resisting surface to prevent surface water from seeping through the base course into the subgrade.

Richer surfaces can be obtained in the case of standard types of pavement by adding an extra seal coat of hot tar covered with fine grits or coarse sand. In the

case of plant mixes, the extra seal coat may be eliminated if the top course is densely graded and enriched with a higher than normal bitumen content. If the top course of a plant mix is made richer, care should be taken to see that it is not laid to a depth exceeding $\frac{3}{4}$ in.

When tight, dense surfaces are not constructed, there is danger that some of the aggregate in the wearing course will work loose. Such a condition is not only undesirable but is apt to cause damage to propeller blades. A tight and enriched surface eliminates the trouble and keeps the pavement plastic so that it does not crack or break excessively if there is settlement in the subgrade.

Conclusion

Only the more important practices and developments in tar road construction during 1940 have been discussed. To sum up, we find that in soil stabilization work the trend has been toward the use of less water than has heretofore been deemed necessary for the mixing and compacting operations; road mixes have been extensively used—particularly the graded aggregate type—although in some localities blade grader mixing has been replaced by mixing in traveling mixing plants, in small inexpensive stationary plants, or by turnover with power shovels; bituminous macadam has been used extensively for widening old roads; the trend has been toward lighter colored and more uniform appearing seal coats and the elimination of slippery surfaces with light surface treatments; on airport construction the trend has been toward the construction of tight, stable, waterproof surfaces.

TABLE III.
CRUSHED AGGREGATE GRADATIONS AND THEIR USES IN TAR ROAD CONSTRUCTION

Sieve No.	AGGREGATE SIZE		GRADATION, PERCENT PASSING SIEVES (SQUARE OPENINGS) BY WEIGHT												USES		
	Nominal Size Square Openings	Approx. Size Round Openings	4"	3 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	2"	1 $\frac{1}{2}$ "	1"	$\frac{3}{4}$ "	$\frac{1}{2}$ "	No. 4	No. 8	No. 16	No. 100			
1	3 $\frac{1}{2}$ "-1 $\frac{1}{2}$ "	4 $\frac{1}{2}$ "-1 $\frac{1}{2}$ "	100	90-100	25-60		0-15		0-5							Broken Stone Base Course	
3	2"-1"	2 $\frac{1}{2}$ "-1 $\frac{1}{2}$ "			100	90-100	35-70	0-15		0-5						Penetration Macadam-wearing course	
5	1"	1 $\frac{1}{2}$ "- $\frac{1}{2}$ "					100	90-100	40-75	15-35	0-15	0-5				Road Mix, Coarse Aggregate Type	
68	$\frac{3}{4}$ "-No. 8	$\frac{3}{8}$ "- $\frac{1}{4}$ "						100	90-100		30-65	5-25	0-5			Cover material for Double (Cold and Hot) Surface Treatment	
79	$\frac{3}{8}$ "-No. 8	$\frac{1}{4}$ "- $\frac{1}{8}$ "							100	90-100	40-75	5-25	0-5			Drag Leveling Course, choke for Penetration Macadam, cover material for Hot Surface Treatment over Cement Concrete and Brick	
8	$\frac{1}{4}$ "-No. 8	$\frac{1}{8}$ "- $\frac{1}{16}$ "								100	85-100	10-30	0-10			Choke and Seal coat for Penetration Macadam and Road Mixes; cover material for Cold Surface Treatments	
9	No. 4-No. 16	$\frac{1}{16}$ "-No. 16									100	85-100	10-40	0-10			Seal coat for Drag Leveling Course and Airport Surfacing; choke for Road Mix, Coarse Aggregate Type
10	No. 4-0	$\frac{1}{16}$ "-0									100	85-100			10-30		Screenings for Broken Stone Base Course

Above aggregate sizes in accordance with Simplified Practice Recommendation R 163-39, National Bureau of Standards, U. S. Department of Commerce

MODERN BRICK PAVEMENTS DEVELOPED BY EXPERIENCE AND RESEARCH

Research Work in Progress and Various Construction Types Described

By W. H. CULLIMORE

Engineer-Secretary,
National Paving Brick Association

VITRIFIED paving brick has been used in this country for over three score and ten years, and dates back to the days of Napoleon in Europe and to Babylon in the pre-Christian era.

The industry has not been content to accept the status quo, and recognizes that research is an essential and component part of progress. Under the auspices of its national trade association, a Research Bureau was established at the Ohio State University Experiment Station in 1935 that is fortunate in having the general supervision of that nationally recognized ceramic authority, Dr. G. A. Bole, with Mr. H. Z. Schofield, Research Director. It is continually endeavoring to contribute information of value to paving brick production and, what is of greater moment, it is "searching out" methods of improving the utilization of the manufactured product.

Research

Test Road.—In 1938 there was organized a co-operation between the U. S. Bureau of Public Roads (now the Public Roads Administration), the State of Ohio Department of Highways and the National Paving Brick Association for the purpose of developing a test procedure capable of appraising the fitness of a given lot of paving brick.

The first phase of the investigation took form during the fall of 1938 in the construction of a test highway on U. S. Route 23 in Delaware County, Ohio. This highway is of 20-foot width, and was constructed with a reinforced concrete base, a mastic cushion and an asphalt-filled brick surface course of 3 in. vertical fiber lug paving brick. The length of the project is somewhat in excess of three miles. From the entire length sixteen practically identical one thousand-foot lengths were selected and devoted, one length each, to the bricks of sixteen paving brick plants. At the completion of construction it was mutually agreed by the three



Rolling Bricks on Boards, Washington Lane, Philadelphia, Penna., Constructed—1940

co-operating organizations that in this project there existed a typically constructed brick pavement in which the behavior of the paving bricks of sixteen different plants could be observed under identical service conditions.

Information from this field phase of the investigation is gleaned through periodic inspections of the bricks of each plant in the following manner: In each plant's section, 20 ten-foot squares, each extending from curb to pavement center line, are laid out with chalk. These 20 squares are equally spaced over the plant's section and are staggered from side to side of the pavement. The inspection then is made by three persons, one representative from each co-operating organization. Two of the representatives examine each brick in the 20 ten-foot squares and mark with chalk each brick which exhibits a defect. The third representative counts and records the marked bricks. The percentage of defective bricks, recorded from the 20 squares, is considered the measure of serviceability of that plant's bricks. Thus far, an inspection of the sixteen plants' bricks has been made after six months of service and again after one year of service. Future inspections will be made at one year intervals.

The laboratory phase of the investigation began at the beginning of brick delivery to the pavement construction site. As bricks were delivered from a plant, it was the procedure to pile them in one uniform stack extending along the plant's one thousand foot allotment. From this stack the three representatives of the co-operating organizations selected three bricks at each five foot point, one brick at each point being assigned to each representative. Thus at the end of construction each laboratory of the three organizations was supplied



Acceptance Test Road, U. S. Route 23, Delaware County, Ohio, Constructed—1938

with a representative 200 brick sample from each of the sixteen plants. Each of the laboratories now has completed the following tests on the sample bricks:

1. Transverse test on 15 bricks.
2. Five hour boil water absorption test on one half of each brick from the transverse test.
3. One standard rattler test (10 bricks).
4. Three modified rattler tests (10 bricks each test; standard rattler test procedure but with brick losses determined at 30, 150 and 1800 revolutions).
4. Two modified rattler tests (10 bricks each test; no shot charge in rattler and with brick losses determined at 30, 150 and 1800 revolutions).

It will be noted that each of the above tests is one which, in some form, has been applied as a paving brick test in the past. However, in this study, each brick entering each test was individually marked so that not only was the average result for the test determined but also the individual brick results which contributed to the average. Thus these tests are being searched thoroughly for value. If these tests, then, are shown to have been outmoded by traffic change, the remaining brick samples stand ready for use in the development of a suitable test.

At this time it is agreed that the test highway has not been in service sufficiently long to permit conclusions on the serviceability of the various plants' bricks or to seriously attempt correlation between laboratory and field. However, it is felt that as this period of service increases, the results will increase in interest and value to the end that the aim of the investigation will be realized.

Brick Filler.—A prominent part of the work of the Research Bureau has been concerned with the development of paving brick joint fillers that are non-exuding in hot weather. Consideration has been given to cement grouts, bituminized cement grouts, plasticized sulphurs and bituminous fillers. Among the bituminous fillers, comparisons have been made between asphalts from different base crudes, asphalts of different softening points and penetrations, asphalt mastics and straight pitches and pitch mastics. In the laboratory the properties and behaviors of the fillers were observed and interpreted in terms of practicability. Special emphasis was given to a test wherein the exuding or receding tendencies of the bituminous fillers were observed by subjecting filled brick panels (of about one square yard each) to prolonged periods of simulated summer temperatures. From these tests a number of fillers were selected as worthy of actual pavement trial.

In cooperation with the Ohio Department of Highways and U. S. Public Roads Administration, a project was planned and completed (November, 1935) in which the entire length of one and one-quarter miles of new brick pavement on Ohio Route 31 in Hocking County, Ohio, was allotted to a test of fillers. Of these, thirteen were in sections exceeding 300 feet in length and eight in sections somewhat shorter. During construction, observations were made to determine the practicability of application, including the surface removal of the fillers. Since completion of the pavement thorough inspections of the fillers under service have been made periodically.

Two-Course Pavements

Technical logic and practical experience combine in establishing the fact that the two-course design for a pavement structure is the most satisfactory and economical for heavy duty traffic such as occurs in metropolitan areas. Such a design includes a base course with a wearing surface. The top or wearing surface will pro-

tect the base against temperature and climatic extremes, decrease traffic impact, check any displacement of the foundation, take the direct abrasive wear of traffic and arrest progressive breakage or deterioration of the base. In other words, a durable course that fulfills the demands of modern motorized traffic will preserve and prolong the life of the base course in a much greater value than represented by its additional cost.

A vitrified brick surface is a type of pavement which can fully meet these requirements.

During the last decade, much advancement and many improvements have been made in the manufacture of paving brick and the design and construction of vitrified brick pavements.

The most outstanding of these improvements are as follows:

1. Manufacture of de-aired brick.
2. Manufacture of vertical fiber lug brick with wire cut wearing surface.
3. Use of mastic bedding course.
4. Rolling on boards.
5. Removal of bituminous filler from surface of brick by use of separating agent.

De-aired Brick.—Up to 1934, the use to any extent of de-aired paving brick was comparatively new, although the process and its product had been established experimentally for several years. Now commercial production is established and a majority of the paving brick plants are equipped to manufacture de-aired brick.

In being driven by the auger machine to the forming cone and die, the clay mixture, broken up or shredded, passes into a vacuum chamber where the contained air is exhausted and from which the mixture is "de-aired" and forced through the forming cone to the shaping die. The clay column then goes to the wire-cutting table and is cut into brick sizes. Removal of air from the clay mixture before die-forming produces a denser and therefore heavier brick, reduces the percentage of absorption, increases the crushing and tensile strength and decreases the rattler loss.

Examination of the brick texture at breaks shows a closer grain and an absence of laminations. Experience to date in paving with de-aired brick has proven very satisfactory and successful.

Vertical Fiber Lug Brick—Wire Cut Wearing Surface.—The character of present day high speed motor traffic and the fact that highway plans in the future will provide for even greater speeds has created the demand that the wearing surface of the modern paving brick must be anti-skid in character.

In vertical fiber lug paving brick the width and length are determined by the dimensions of the die and the depth by the spacing of the wires on the cutter, thus providing the wearing surface with a roughened or deformed surface of high skid-resistant character.

Formerly, the repressed and the wire-cut lug type with smooth surface were in general use and their preference was based on their having side lugs, considered essential for the proper sealing and filling of the joints.

However, the manufacture of brick having a wire-cut wearing surface with lugs on the sides and ends is commercially practical and this type, known as the vertical fiber lug, is now the most popular single variety in the United States.

Mastic Bedding Course.—The bituminous mastic bed is generally used on two-course brick pavements, although untreated sand, stone screenings, rock asphalt



View Showing Construction—Vibrated Monolithic Brick Road—Ohio. Plastic Concrete Base and Center Expansion Joint in Foreground. Brick Surface Course Being Laid and Vibrating Equipment in Background

and sand-cement are also used. The mastic material has the advantage of being waterproof and stable and of having considerable ability to bridge over cracks in the base. The problem is to obtain a mixture that will contain ample bitumen content, that can be prepared without expensive plant equipment and that can be readily handled and shaped. The specifications in general use for mastic bed call for a bituminous material of cut-back asphalt or tar in the proportions of 8 to 5 percent bitumen material to 92 to 95 percent fine aggregate.

Rolling on Boards.—Rolling on boards is a more or less recent innovation in rolling the brick after they have been laid and before the filler is applied. The method originated in Richmond, Va., and is meeting with favor elsewhere. It was required on the Lincoln Tunnel pavement laid in 1937. It has the advantage of permitting the use of heavier rollers such as most contractors have on hand for sheet asphalt construction. The brick are uniformly embedded vertically with a maximum displacement laterally. The joint lines remain straight which is desirable from the standpoint of appearance.

Surface Removal Method.—Probably the most important improvement in the technique of building a brick pavement has been the method of removal of surplus filler material during construction. The film of asphalt, which remained on the surface of the brick for sometime after the job had been completed, was a source of trouble and criticism because of possible slipperiness in wet weather and stickiness in hot weather. The principle of surface removal is to find something which will cause separation of the asphalt from the brick. It is not necessary to provide a film of any kind of solid substance. Ordinary water would do the job if the moisture could be retained for a sufficient length of time to allow the asphalt to be peeled off. Consequently it is necessary to provide an agent which will cause the moisture to be retained to permit the asphalt to be removed. The following solution has proved most successful as a separating agent:

Calcium Chloride—35 percent.

Laundry Starch—1 percent by weight.

Water—64 percent.

The separating agent is applied after the laying and rolling of the brick and immediately prior to the application of the asphalt filler. It is applied with pressure sprayers or whitewash brushes, care being taken not to allow the agent to flow down into the open joints. The filler is then poured on the brick surface rather than with squeegee buggies as it is easier to remove the thick sheets or strips. No squeegeeing or

luting into the joints is necessary and in the case of partially filled areas, the surface receives a second application.

When the filler has partially cooled, the surface mat of filler is cut clean from the brick in strips not more than four bricks wide by the use of sidewalk cleaners or scrapers. Particular care must be taken to avoid pulling the filler from the joints by using a sharp thrusting motion of the scraper. The final result will be a clean surface with joints 100 percent filled, with all surplus material entirely removed, leaving a non-skid brick surface. The salvaged material may be reheated and reused, but the proportion of reheated to new asphalt in the heating kettle should be such as to minimize foaming.

The surface removal method has now become practically universal practice.

Investigation by Messrs. Stinson and Roberts, reported to the Highway Research Board, indicated that the coefficient of friction, both rolling and sliding, on "A vertical fiber brick road, free of asphalt filler" was practically the highest of any types that were included in their tests.

Vibrated Monolithic Pavements

Improvement in modern road design and construction was accomplished by the Ohio Department of Highways in the building of two sections of vibrated monolithic brick pavement in 1938 and 1939. This modern type of brick pavement, having provision for volume changes and crack control and utilizing mechanized construction methods, is meeting with increasing favor, particularly for highways.

Briefly described, the concrete base is constructed in the usual manner, with the addition of vibratory finish to provide a denser and stronger slab, true in longitudinal grade and transverse cross-section. Within an hour or two after the finishing of the concrete base and installation of expansion and contraction joints, the brick are dropped from conveyors directly on the wet plastic concrete surface. A vibratory machine, specially designed, and running on steel side forms, then moves forward slowly over the brick surface, with intermittent pauses to prevent dragging, planing the surface to the true cross-section and vibrating the brick into the plastic concrete base. The average penetration of the brick into the concrete base is $\frac{1}{8}$ inch, forcing the mortar up between the points from $\frac{1}{4}$ to 1 inch. The grouting machine, with a chute, mounted on a frame with wheels riding on the side forms, deposits the cement mortar



Squeegeeing Cement-Grout Filler Into Joints on Vibrated Monolithic Brick Road in Ohio. One Bag Cement Mixer Mounted on Frame Runs Along Side Forms



Reinforced Brick Pavement in Springfield, Illinois—Constructed 1940. Rolling 8 in. by 8 in. by 3 1/4 in. Brick Units

over the surface of the brick. The initial application is squeegeed into the joints, and if necessary, a second application of thicker grout is applied until the joints are filled flush with the brick surface.

The longitudinal center joint and transverse expansion and contraction joints are installed throughout the entire depth of the concrete and brick slab, thus controlling and preventing, particularly, irregular longitudinal cracks which were prevalent in the old monolithic brick roadways.

Typical Roads.—The successful construction of the first two sections and the splendid performance to date of the brick surface under heavy traffic resulted in the Ohio Department of Highways awarding three more contracts in 1940 for the construction of this modern type of brick roadway.

One contract embraces the construction of 2.4 miles of vibrated monolithic brick roadway on U. S. Route 40 (The National Highway) in Guernsey County, approximately 2 miles west of Cambridge, Ohio. The roadway is 24 feet in width, including special vitrified brick lip curbs and is being built on a 9-7-7-9 in. reinforced concrete base. The two lanes of roadway now being constructed will later serve as one side of a proposed divided highway.

The other contract is a continuation of the 1939 project in Stark County, U. S. Route 30 (The Lincoln Highway), starting in the town of Robertsville and extending west for a distance of about 3 miles. This contract consists of a 22-foot roadway, including special vitrified brick lip curbs, and is being laid on a 7-5-5-7 in. reinforced concrete base. The project also included two bridges on which all exposed masonry is faced with brick.

The essential difference of design between the pavement on the Stark County project and similar pavements built during the last two years is that the base section is 7-5-5-7 in. rather than the usual 9-7-7-9 in. The difference in the construction practice consists of constructing the pavement slab one-half at a time. Center joints are tied together by means of $\frac{5}{8}$ in. deformed round steel reinforcing bars and an impressed key-wav in the base slab. The equipment used is essentially the same as that which had been used previously in full width work. One advantage found in the one-half width construction is that two complete brick dropping crews could be utilized, each working in adjacent slab intervals between joints. This enables the brick dropping operation to easily keep up with the progress of the paving mixer and several runs of 1600 lineal feet of pavement a day are obtained.

Reinforced Brick Pavement

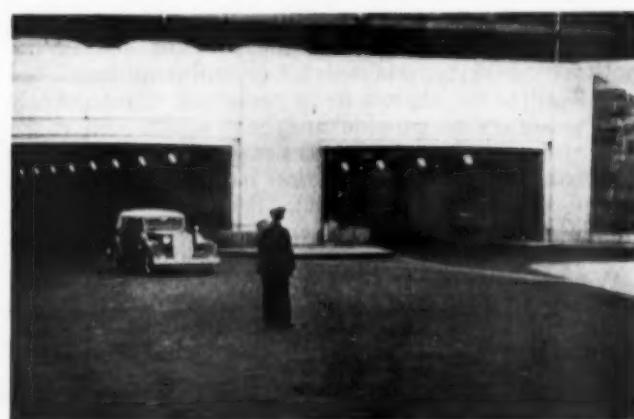
In 1931 an Illinois paving brick manufacturer installed a section of reinforced brick pavement in the driveway leading to the brick plant. The brick were laid in a "basket-weave" manner, with three brick constituting a unit. Reinforcement of $\frac{3}{8}$ in. round deformed bars was placed at $8\frac{1}{4}$ in. centers, both ways, 1 in. from the bottom, and all joints filled with 1:2 cement mortar. After the slab was completed, an excavation under one side was made, creating a clear span of about 5 feet. An attempt, without success, was made to break down the slab by test trucks. It is estimated that approximately 30,000,000 paving brick have been trucked over the pavement slab to date, without it showing any signs of distress.

In 1937, an additional test section, 38 feet wide and 75 feet long, was constructed on West Grand Avenue in Springfield, Illinois. Instead of using standard sized paving brick, a larger vitrified brick unit $3\frac{1}{2}$ in. by 8 in. by 8 in. was manufactured and installed in the same manner with reinforcing steel bars and cement-mortar filled joints. During three years of service under heavy traffic, the pavement has shown no signs of failure.

As a result of observation of the original test section on West Grand Avenue, in 1940 the Illinois State Highway Department awarded a contract for approximately a mile stretch of this pavement to further check and observe the design under heavy, fast moving traffic.

The contract extends east on South Grand Avenue from Wheeler Avenue beyond the city limits down old Rochester Road to the belt line. This will be a much travelled road to Lake Springfield.

The brick units being used under this contract are of an improved design over those used in the 75-foot section on West Grand Avenue. The new brick units, which are $3\frac{1}{4}$ in. by 8 in. by 8 in., have lugs on two sides which act as brackets to hold the longitudinal reinforcing bars in place. On the same side of the brick units, above the lugs, are horizontal grooves to provide a better bond between the brick units and the cement-mortar filler. The transverse bars are supported on the longitudinal bars. Each brick has two longitudinal core holes ($\frac{3}{4}$ in. diameter) through the entire length. At expansion joints (spaced at 50-foot intervals) a $\frac{3}{8}$ in. smooth dowel bar, 8 in. long, is inserted in the core holes of the abutting brick, extending to the center of each of the bricks, thus dowelling the two slabs across the joints. A bituminous or premoulded filler is used at the expansion joints. Transverse reinforcing bars are



Queens Midtown Tunnel—New York City. Completed and Opened to Traffic November 15, 1940. Vertical Fiber Lug Brick Laid on Mastic Cushion With Asphalt Filler in Joints



Attractive Pattern of Permanent Marker Brick of Contrasting Color. Highland Avenue in Baltimore City. Constructed—1940

left out at the expansion joints. The mortar filled joints between the brick units are $\frac{3}{4}$ in. wide.

While this section of reinforced brick pavement is still in the experimental stage, it will be observed with much interest during the next year, to determine its ability to give satisfactory service and withstand the effects of high speed and heavy traffic customary on main highways.

Tunnel Projects

Vitrified paving brick is playing a prominent part in the tunnel system of highways in New York City. Designed to relieve the congestion on bridges and city streets and to provide a fast moving artery for through traffic, the tunnels which have been completed and opened to traffic are carrying a steady flow of concentrated passenger and truck traffic. The Lincoln Tunnel was opened to traffic on December 22, 1937, and on November 15, 1940, traffic started using the new Queens-Midtown Tunnel. The tube roadways and approaches of both tunnels are paved with vertical fiber lug brick on a mastic cushion, with asphalt filler in the joints. It is estimated that about 10,000,000 cars per year will use these tunnels.

A recent inspection trip disclosed that the vitrified brick roadway in the Lincoln Tunnel, after three years of concentrated traffic, is in splendid condition and no repairs or replacements have been necessary during this period of time.

Lane Marker Brick

The use of brick of contrasting color for permanent traffic lane markers has come into prominence during the last five years. In some cases, double rows of brick, laid longitudinally, serve as a center line, but more often, particularly on city streets, the brick are laid transversely, alternating every other brick, or in attractive patterns as shown in the accompanying illustration. In Baltimore City, in addition to the center lines and traffic lanes being defined with marker brick laid longitudinally for automobile traffic, pedestrian walks are defined at the intersections by installing a double row of marker brick across the curb and building lines.

The installation of permanent marker brick is not only attractive and an aid in the steady movement of traffic but of more importance is economical.

CONSTRUCTION PRIORITY FORMULA AIDS DECISIONS

A suggested mathematical formula to determine the order in which the necessary improvements should be made on West Virginia's highways was submitted by the Planning Division to the State Roads Commission for consideration. The Division pointed out that the formula for priority gives major consideration to present use of the highway in relation to the present degree of improvement and further adds that the priorities are not designed to supplant engineering judgment and other factors which necessarily must carry considerable weight in determining the improvement program. The priority formula, however, would narrow the field for judgment so that a more standardized basis for determining improvement can be used. A road could merit improvement priority in one or more of each of the following classifications: Surface widening, resurfacing, relocation and surface reconstruction. For instance, to establish a priority for surface widening a particular road 10 feet and under in width should carry over 25 vehicles per day. If the traffic is under 25 vehicles per day a 10 foot surface would be judged sufficient. By the same token the 18 foot pavements which were constructed 10 or 15 years ago would be adjudged sufficient provided traffic remains under 500 vehicles per day. But once that maximum traffic point is reached a priority would be established for that particular road for future widening.

A graded and drained road, once traffic reaches 50 vehicles per day, would establish a priority for resurfacing to at least next higher type of surface. A metal surface road carrying more than 100 vehicles per day would establish priority for improvement by a low-type bituminous surface. Naturally, in addition to the mathematical formula, other factors would be determinants in the priority ranking of a particular road section.

The Planning Division further states in explanation of its recommendations:

"A road must be considered obsolete if the alignment, that is sight distance, curves, and grades, presents the free movement of the vehicles using it or constitutes a danger to the traveling public. A road is deteriorated when it becomes rough, uneven, and dangerous and the cost of maintaining it in a satisfactory condition is excessive.

"When either or both of these conditions exist it is necessary to reconstruct a pavement. When the old pavement is retired, it means a pavement death which affects the average pavement life. Therefore, roads which become obsolete, sometimes cause an early retirement of an otherwise serviceable pavement. The road life study, in arriving at the life expectancy of pavement, utilized all retirements including those because of obsolescence and the expectancies set up must be considered as expectancies developed on past experience and not necessarily reflecting what can be expected in the future. However, if construction and maintenance policies in the future are similar to those in the past the expectancies should follow the same trends. Certain types of pavements, of which only a small mileage has been constructed, should not be considered as definitely reflecting the life expectancy of that type of pavement."

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ Herewith a museum piece, the granddad of them all. It rests in



the yard of the Buckeye Traction Ditcher Company of Findlay, Ohio.
—Sent in by Bert Brumm.

¶ For making inspection of fissures, cracks in concrete and earth formations where an ordinary light cannot reach, a novel flashlight bulb extension has been developed. It is made in lengths from 6 in. to 36 in. This extension has a plug which will screw into any flashlight with the bulb in the opposite socket. It can be inserted in cracks or other small openings so that the light can reach



difficult-to-get-at places. It is a handy device for inspectors. Being bendable, it can do down into intricate mechanism. It can also be made into a hook shape or can be fashioned into its own stand and set in position so that both hands are free to work. It's a handy accessory for any technician's tool kit.

¶ His car took him from his home to the office.

The lift took him from the vestibule to his own particular room.

His secretary took it down when he wished to write a letter.

And he could always reach the telephone without rising from his chair.

So naturally the great morning paper welcomed his views on the exhausting rush of modern business life.—*From California Public Works.*

¶ Lining the sides of U. S. 77 for a couple of miles south of Oklahoma City are more advertising signs than I have seen anywhere in the U. S. on my travels.

¶ On U. S. 77 southwest of Victoria, Tex., I noted an excellent roadside development or beautification idea. Trees planted to obscure culvert and bridge ends or flat views around curves were cut off approximately four or five feet above the ground. The lines were true and the effect very pleasing.

¶ While I'm down in Texas I want to pass a critical remark about the muddy condition of U. S. 59 at the east side of Victoria. A pipe line supply company has a warehouse on a cross road intersection and the hauling trucks cut the wide, flat intersection quite badly, lugging mud onto the pavement.

¶ Another remark about Texas. Only this one is more complimentary. South of San Antonio I noticed some experimental stretches of jet black raised center line markings. It was quite a relief to cross or to strike as contrasted with the many miles of slippery [when wet] center line marking in the state.



¶ A. P. J. compliments Texas on that long stretch of excellent new concrete pavement on U. S. 281 north of Three Rivers and on State Route 9 toward Corpus Christi.

¶ About 25 miles south of Dallas, Texas, on U. S. 77 is the most abominable railroad crossing I know. I travel fast as a matter of necessity. When I hit this peaked crossing I all but zoomed into Dallas. Dangerous, that's what it is.

¶ Out on U. S. 30 west of Laramie, Wyoming, is this freak of nature—a wind-whipped pine tree growing out of a rock. The sign board attached to the fence reads as follows:



THE OLD PINE TREE

The original line of the Union Pacific Railroad passed this point, and pioneers say that the surveyors were ordered to slightly deflect the route to avoid destruction of this "freak."

It is said that early day firemen of passing trains realizing the tree's necessity for moisture, drenched the tree daily with a bucket of water.

The estimated age of this rock bound sentinel is eighty years.

*Wonderful Wyoming Society,
Sep. 1935.*



¶ The Road Show before the days of the extensive use of rubber. Some difference from the Chicago Show.

¶ J. H. Dowling, State Highway Engineer of Florida, returned to his office about Nov. 26, last year, after some time spent in convalescing from an operation. With that Florida weather what it is that time of the year, convalescing must have been an extreme pleasure.

¶ The close proximity of water mains to the surface of this street in Deerfield, Ill., prohibited the use of pavement breakers or skull crackers. To break up the old 6 in. concrete base which had a 2 in. bituminous surface, the Meyer Construction



Company used an extra-heavy-duty rooter and diesel tractors. It was feared that dynamite or a skull cracker might displace or crack adjoining slabs also.

¶ This picture shows the use of plain coal as ballast for a railroad siding which was being constructed to a new army camp site near Hitchcock, Texas, which is only a few miles northwest of Galveston on

State Route 6. The division engineer of the Santa Fe R. R. happened to be present at the time Mr. Van London and I [“I” is Mr. M. B. Hodges, Maintenance Engineer, Texas Highway Dept.—A. P. J.] were there and he explained that ships returning from Europe had brought the coal back as ballast and, as I recall, it is



from Wales. The Santa Fe had purchased it as ballast for the siding as it was cheaper than any other material which they could use for this purpose. The bulldozer is throwing the material against the ties after it had been dumped from cars, one or two of which can be seen in the picture. You may have heard of coal being used as rail ballast before but no one around these diggings has.

¶ Nearly a quarter of a million people in the states of Washington, Oregon and Idaho live in 2,070 communities that are not served by rail. They depend entirely upon motor transportation.

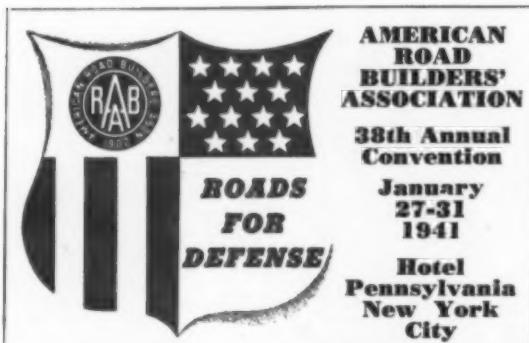
¶ Probably what is the biggest tire chain in the world is shown in contrast to an ordinary automobile tire with chain on it. This outfit was at work on a rocky, rough grade on highway work near Johnstown, Penna. The American Chain and



Cable Company made this hugest of all tire chains which at the same time is a virtual protective “chain link armor” for the tires.

¶ Going south out of Kansas City, Kans., I noticed some strange traffic line markings. The continuous center line was black but on hills and curves the caution line for no passing was red. It was practically useless during a rain and of no value, so far as I could tell, at night.

¶ When one ceases to adventure, he begins to die.



American Road

WASHINGTON, D. C.

ARBA ANNOUNCES HEADLINERS FOR

Down the Road

By CHARLES M. UPHAM

International Highway Authority

NEW ROADS FOR THE NEW YEAR

The stroke of midnight, December 31, heralds the birth of a new year. With it come new duties, new conflicts, new trials and new opportunities. New Year's Day represents a milestone where we pause for a last look at the past and then march forward with confidence into the future. January, as the first month of a new year, is particularly a season of preparedness. The individual makes resolutions to prepare him for a better and happier life. The business organization takes inventory and makes plans to prepare for enlarged operation and greater profit. The nation prepares to preserve the rights and liberties of its citizens, while it offers broader opportunities to all.

Preparedness, in this last sense, has particular significance for Americans in 1941. The main energies and resources of individuals, industries and government are combined in a giant-sized preparedness program. Uncle Sam is burnishing his sword and polishing his shield. A navy second to none, an army tops in manpower and equipment, an air force to rule the airplanes—that is the goal of national preparedness. While the nation's armed forces concentrate on training and maneuvers, American business plans to reinforce these efforts by economic and industrial mobilization.

Capital, labor and agriculture—with all the units, large and small, that make up these major classifications—must present a united front in support of the American way of life. There can be no more appropriate time for planning the contribution each group must make to the national welfare than this month of January. Serious consideration will, therefore, be given to

the role of roads in the nation's preparedness program when the American Road Builders' Association meets for its 38th annual Convention in New York City, January 27-31. With "Roads for Defense" as convention theme note, the nation's No. 1 highway organization will map its future activities in behalf of the nation's well-being, with emphasis on the present emergency. Federal Works Administrator John M. Carmody, Public Roads Commissioner Thomas H. MacDonald, Arizona Senator Carl Hayden, California Senator Sheridan Downey and U. S. House Roads Committee Chairman Wilburn Cartwright head a list of outstanding federal, state and local dignitaries, highway authorities and military experts who will speak on subjects vital to every American.

Highway history will be made at this conclave. The decisions that are reached and the plans formulated may remap the American landscape. Every group concerned with highway legislation, administration and construction in North and South America will be represented. Parleys will determine what kind of roads are needed, where they should be built and how they can best serve national defense needs. Because of the exceptional importance of this meeting, I wish that every one of the nation's newspaper editors and trade-paper publishers could be on hand for convention sessions. No group has been more valuable in spreading the gospel of better and safer roads than the American Press. I feel a deep personal gratitude to the daily and weekly newspapers, the motor-club and civic-association magazines and the trade publications that have cooperated by continued publication of "Down the Road." There is no more potent means of reaching the mind and heart of America than through the columns of its newspapers and magazines.

John M. Carmody, administrator, Federal Works Agency; Thomas M. MacDonald, commissioner, Public Roads Administration; Arizona Senator Carl Hayden and Oklahoma Congressman and House Roads Committee Chairman Wilburn Cartwright, co-authors of federal highway legislation, and California Senator Sheridan Downey, member, Senate Military Affairs Committee, will be headline speakers at the 1941 Convention of the American Road Builders' Association at New York City, January 27-31.

ARBA President Hal G. Sours, Ohio director of highways, will open the Roads-for-Defense Forum on the first day of the conclave. Canada will be represented at this forum by R. M. Smith, deputy minister of highways, Toronto, Ont., while Nelson Rockefeller, co-ordinator of commercial and cultural relations between the American republics, will speak with authority on Pan-American affairs. Patriotic presentation of an All-American song will wind up the forum on an inspirational note.

Convention sessions will be interspersed with inspection tours that will take delegates to the outstanding construction projects in and near Manhattan. Trips will be made as guests of the New York City Department of Parks, the city engineer's office and the New Jersey State Highway Department. Entertainment highlight of the 1941 Conclave is the Road Builders' Mardi Gras, annual ARBA banquet, in the Waldorf-Astoria Grand Ballroom, January 29. Stars of stage, screen and radio will share the spotlight. The "good neighbor" policy will have concrete illustration at the Pan-American fiesta and veteran Road Builders will bring back the "good old days" at the Old Timers' Shindig.

Novel devices will be utilized to vary the pattern of Convention sessions. Speeches and reports will be interspersed with panel discussions and question-and-answer periods.

Convention headquarters will be the Hotel Pennsylvania. Room reservations should be sent direct to the hotel. There is no time to lose if you want to be sure of desirable accommodations. Tickets for the Road Builders' Mardi Gras can be obtained from ARBA National Headquarters, International Building, Washington, D. C.

Builders' Review

JANUARY, 1941

"ROADS FOR DEFENSE" CONVENTION

PUBLIC RELATIONS TO HIGHLIGHT 1941 MEET

A nationwide public relations campaign for the highway industry and profession will be planned at the 1941 ARBA Convention. Outstanding newspaper, advertising and publicity men will contribute to discussions of ways to sell good roads to the public at the public relations forum. Addresses scheduled include "Telling the Federal Works Story" by Forrest Allen, chief, information division, Federal Works Agency; "Moral and Spiritual Roads for Defense" by Edward L. Bernays, America's foremost public relations counsel; "The Employee Magazine and Public Relations" by Harry H. Anderson, vice-president, personnel, Shell Oil Co., Inc.; "A Co-operative Campaign for Weekly America" by Charles Emde, business manager, American Press Association; "Pictorial Public Relations" by Rudolf Modley, president, Pictograph Corp.; "Roads and the Country Press" by William Gordon, Western Newspaper Union, and "Thirty Million Eyes" by Jack Gordon, Movietone News. Delegates will inspect New York's leading newspaper and radio facilities.

PENNA. CONSTRUCTORS STAGE SUCCESSFUL MEETING

The Associated Pennsylvania Constructors staged its annual convention and banquet at the Penn-Harris hotel, December 11-12. Banquet speakers were Michigan Congressman Jesse P. Wolcott, ranking minority member, House Roads Committee; Pennsylvania Secretary of Highways I. Lamont Hughes, Robert W. S. Smyth, chief, project reviewing unit, Civil Aeronautics Authority Airport Division, and ARBA President Hal G. Sours, Ohio Department of Highways. ARBA Engineer-Director Charles M. Upham addressed the annual meeting on "Effect of the Highway Economic Program on National Defense." Other speakers were ARBA Airport Division Manager William C. Slee on "The ARBA Airport Division Program," ARBA General Counsel Francis J. Kelly on "Federal Laws and Their Effect on Highway Contractors," S. S. Riddle, manager, industrial relations bureau, Pennsylvania State Chamber of Commerce, on

"Merit or Experience Rating for Employer's Contribution to Unemployment Compensation Insurance" and Mr. Smyth on "Our National Airport System of the Future." A. E. O'Brien, secretary of the Pennsylvania ARBA affiliate, made his annual report. C. H. Buckius, assistant secretary, and Thomas Frame, chief engineer, state department of highways; Thomas Evans, acting chairman, and Samuel W. Marshall, chief engineer, Pennsylvania Turnpike Commission, and C. E. Swain, district engineer, U. S. Public Roads Administration, addressed the luncheon-meeting.

PRESIDENT SOURS STRESSES ARBA CONVENTION IMPORTANCE



ARBA President Hal G. Sours invites every road builder, planner and administrator to the 1941 Convention. He declares, "At this time of widespread public realization of our needs for an adequate national defense, it is as much the duty of road builders to convene and form a sufficient

AMERICAN ROAD BUILDERS' ASSOCIATION

38th Annual Convention

January 27-31, 1941

Hotel Pennsylvania
New York
City



program to further this cause as it is for the federal government to shape the general welfare of the nation."

NERBA ANNUAL DINNER OUTSTANDING SUCCESS

Massachusetts Senator Henry Cabot Lodge, Jr., was principal speaker at the annual dinner of the New England Road Builders' Association, December 9. Entertainment for the 1,500 road builders who attended included vaudeville, musical comedy, night-club and specialty acts. Among honor guests were Governor J. Howard McGrath of Rhode Island, Attorney-General Paul A. Dever of Massachusetts, New Hampshire State Highway Commissioner Frederic E. Everett, Vermont State Highway Board Chairman W. F. Corry, Massachusetts State Immediate Past-Highway Commissioner John W. Beal and ARBA Engineer-Director Charles M. Upham.

AED MEET TO PRECEDE 1941 ARBA CONVENTION

The annual meeting of the Associated Equipment Distributors will be held in New York City, January 25-27, immediately preceding the 1941 ARBA Convention. AED headquarters will be the Commodore hotel. The organization includes 300 of America's leading distributors, with their affiliated manufacturers. Morton R. Hunter, acting secretary, is in charge of arrangements.

MAINE ARBA AFFILIATE HOLDS QUARTERLY MEET

Quarterly meeting of the Maine Good Roads Association was held at Augusta, December 17. Speakers included Guy P. Butler, manager, Maine Publicity Bureau, on "The Importance of Roads to Recreation"; Frank Washburn, commissioner of agriculture, on "The Importance of Roads to Agriculture"; Joseph B. Campbell, secretary, Maine Petroleum Industries Committee, on the need for a constitutional amendment to safeguard Maine's road funds, and A. E. Barnard, manager, Maine Automobile Association, on "What's Ahead in Highway Laws and Finances?" W. S. Anderson is president of the ARBA affiliate.

Trends

IN ASPHALT ROAD CONSTRUCTION

Indicate Wider Use of Plantmix and Soft Asphalt Cements

By A. H. HINKLE

*District Engineer,
The Asphalt Institute*

WHILE the evolution of road construction, particularly of the bituminous type, often seems confusing, a careful study will show that in the long run a general trend in respect to certain changes is taking place. This trend is influenced by:

- (1) the change in character of traffic from year to year;
- (2) the development of new machinery;
- (3) experimental and research work being carried on by the state highway departments and various other governmental agencies resulting in new discoveries;
- (4) the change in the cost of different materials used in the road construction work, as they are also influenced by new developments.

Softer Asphalts Used in Hot Plantmix

While the average sheet asphalt and bituminous concrete pavement used 45 to 55 penetration asphalt a few years ago, now a softer asphalt is generally used. The state highway department of Kentucky has specified 85-100 penetration asphalt in the bituminous concrete used on state highways. Ohio State Highway Department now uses 85-100 penetration asphalt on much of its bituminous concrete of the hot mix type. It is recommended that 120-150 penetration asphalt be used for airport runways surfaced with bituminous concrete of the hot mix type. Much of the runway is little used by traffic—hence, this softer grade is desirable. Some of our large cities that construct sheet asphalt for heavy duty streets still use a fairly low penetration asphalt,



Fig. 1.—Laying Bituminous Concrete With Machine Secures a Perfect Riding Surface and Eliminates Most of the Hand Labor

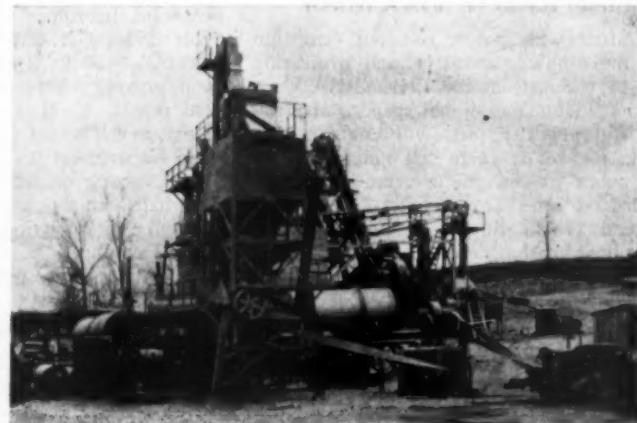


Fig. 2.—A Modern Semi-Portable Hotmix Plant Operates Much More Economically Than the Old Time Plants

but even here the trend is toward softer asphalts, especially on light traffic streets.

It must be recognized that the use of the softer asphalts is generally associated with the more careful grading of the aggregate, dependence for stability being placed more upon the gradation of the aggregate than on the hardness of the asphalt. This is a most important factor with bituminous mixtures. While research along this line has not been exhausted, it has been well explored to a point where certain results for a pavement can be predicted when the mixture is constructed to accommodate certain traffic conditions. Perhaps the general use of softer asphalts and a more definitely graded aggregate are among the most outstanding of the developments in the use of bituminous concrete and sheet asphalt that have been placed during the past few years.

Plantmix Replacing Roadmix

It is to be noted that the plantmix surfaces are, in many locations, replacing roadmix. The state highway department of Michigan might be cited as one of the best examples. This department now is using plantmix bituminous construction almost entirely, except on very small projects. This state constructed about 225 miles of plantmix oil aggregate surface and about 100 miles hot plantmix bituminous concrete in 1940. West Virginia which formerly used the roadmix type on a large part of its state highway system is inclined now toward the plantmix type.

While there are still thousands of miles of roadmix constructed annually throughout the country because of

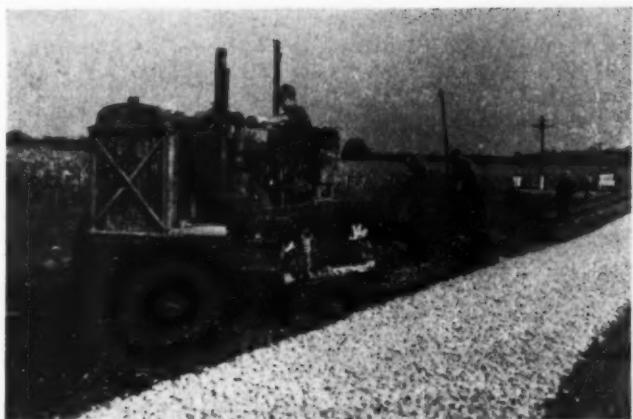


Fig. 3.—Crawler Tractor and Multi-Blade Mixing Spreader Making Roadmix Binder Course to Level an Old Second Class Bituminous Concrete Hot Mix Top to Convert It Into a Heavy Duty Road

special conditions which make it most practical, the following reasons account for the well defined trend toward plantmix types:

(a) A more *definite and uniform mix* made under more positive control can be had with the plantmix than with the roadmix. While it is true that long experienced crews, making roadmix with a certain aggregate, uniform as to grading and quality, have accomplished wonderful results, it may take years to develop an equally efficient crew on some other aggregate under other conditions.

(b) Plantmix prices have lowered materially in recent years due to development of more efficient machinery for both mixing and laying and to lower costs of transportation. More efficient hot mix plants have been most important factors in lowering the cost of this type. Continuous mixers which will further lower the costs of this type are now being greatly improved. Bituminous pavers and finishers have greatly reduced the cost of laying the bituminous concrete as compared to hand methods. Other newer machines now in the experimental stage are claiming still lower costs for spreading some of the plantmix types.

(c) Plantmix can be made under much more *unfavorable weather* conditions (because of the drying of the aggregate) than is possible with roadmix. During rainy weather roadmix progress may be handicapped because of high moisture content of the aggregate. This has delayed obtaining the best results on many projects. While under ideal conditions of weather and aggregate and experienced crews, roadmixes have been made that have the appearance of being equal to many plantmixes, such results cannot be guaranteed under adverse conditions. Plantmix (where the aggregate is uniformly dried before coating with the asphalt), also will require less maintenance on the average in the way of surface treatments and patching in future years. Roadmix therefore is better suited to arid or semi-arid areas, or where work can be completed well within warm weather periods.

(d) In many places the roadmix is still used as a leveling (and binder) course to level an old rough and irregular surface, and then be topped with a plantmix surface.

Plantmix laid with mechanical finishers levels almost perfectly an old rough surface if the waves or irregularities are not too far apart. However, the longer dips in the road cannot be spanned with a short wheelbase. For this reason there will always be more or less road-

mix used. It would of course be possible to spread certain cold plantmixes with the long roadmix drags and planers and thus secure the same leveling effects as are secured with the roadmix types. This class of work has not yet taken on any great proportion—it is possible that it may in future years.

Trend Toward Hot Plantmix on Heavy Duty Roads

This trend is particularly noticeable on the state highway work of Ohio where both cold and hot plantmix materials have been used for a number of years. The cold mix has gradually given way to the hot mix type. This tendency is perhaps accelerated by the resurfacing necessary on the old pavements where heavy traffic prevails. The hot plantmix is quite stable almost as soon as laid and rolled and will immediately carry the heaviest of traffic.

Influence of Aggregate on Mixtures.—It is well known that some aggregates hold the asphalt in a cold mix much better than others. In West Virginia for instance, apparently the Appalachian Blue Limestone is recognized as excellent aggregate for cold mix (amiesite type). Some of the engineers of this state are very frank in announcing that they do not get the results from limestones from some other sources that they get from their own "Appalachian Blue Stone." Observations made on the work in that state would indicate that this claim has some foundation. This state has constructed a large mileage of very successful coldmix type. However, apparently the country as a whole is tending toward the hot mix type on heavy duty roads. It is easily possible to lay most so-called cold laid types as hot mixtures, and this is being done in many areas, by simply cutting the percentage of liquifying agent.

Aggregates for Plantmix Base Construction

There is a growing interest in the use of bituminous concrete as a base as well as a top surface. This is largely induced by its lower cost in recent years. This lower cost is the result of (a) lower price of asphalt; (b) the use of lower cost aggregates that are suitable for base and that were formerly frequently prohibited by rigid specifications without justification, and (c) the development of more efficient mixing machinery as well as spreading and laying machinery, which has greatly increased output from a given plant setup.

The relative cost of pavement of this type of base as compared with some other types is largely dependent upon the availability of aggregates suitable for the bituminous concrete base construction. While a high grade aggregate should be specified for the surface of



Fig. 4.—Two Pavers on a Michigan State Highway Operating about 250 ft. Apart Laying Oil-Aggregate the Full Width of a 20 ft. Pavement. Traffic Permitted to Use Road Without Even a Watchman to Direct it. This Illustrates How Modern Machinery and Materials for Road Surfaces Have Been Developed to Speed Up the Work and Better Accommodate Traffic

any type of road and is very desirable in the top inch of plantmix bituminous concrete, there is little justification for specifying the same aggregate for use in base courses of this type. It is apparent that a higher abrasion loss aggregate may be used in the base courses of hot-base asphaltic concrete than in the top. In the base the aggregate is not subject to direct wear; it is saturated with asphalt and firmly bonded together. All that is necessary for high durability is to have the surface protected from abrasion, and composite pavements of low cost base and relatively thin higher cost surfaces are possible in many areas at great savings over present methods.

It is well known that some aggregates may be suitable material in bituminous concrete of the hotmix type which are not suitable for other types of pavement. This is not only true of some limestone but is particularly true of gravel aggregates. In some locations sand for other types of pavement must be shipped for long distances whereas fine aggregate for the bituminous concrete of suitable quality can be secured locally. It would appear that in some of the sandstone outcrop areas that suitable aggregates for making bituminous concrete for base work can be secured at a nominal cost as compared with suitable shipped-in aggregate.

As examples of aggregate suitable for bituminous concrete being much cheaper than aggregates for other types, there might be cited several projects on which bids were taken this past year by the state highway department of Kentucky. On these projects bids received on the bituminous concrete base and top were materially less than bids received for competing types. The latter was 22 feet wide, 9 in.-7 in.-9 in. section with 3-in. lip curbs. Bituminous concrete design consisted of 1-in. screenings for insulation over subgrade and 8-in. bituminous concrete consisting of two base courses 24 feet wide and two top courses (binder and surface courses 2½ in.), 22 feet wide.

In exploring some of the states for suitable aggregate for bituminous construction, it is evident that the field has not in any way been exhausted. The state highway department of Michigan has done an unusual job in exploiting the local aggregates for use in bituminous construction. Since 1935 this state has built approximately 1,000 miles of hot plantmix oil-aggregate construction, using local aggregates almost entirely.

Oil-Aggregate Plantmix on Secondary Roads

Most engineers are quite familiar with oil-aggregate



Fig. 5.—Bituminous Concrete Drive. Its Freedom From Cracks and Ease of Repair, Together With Its Color Which May Be Made to Blend With the Surrounding Landscape, Make It a Desirable Material for Such Use



Fig. 6.—Two Center Drives Treated With ¼ gal. MC-5 and 22 lb. ¾ in. Slag-Aggregate Cover, One Year After Application

plantmix now being so extensively used by the state highway department of Michigan. This type is usually constructed 2½ in. thick (laid in two courses) on a gravel or stone base. Generally road oil of SC-4 grade (Institute specifications) is used in this mixture. However, experiments have been carried on with a heavier grade and it is believed that SC-5 or an even heavier grade will make a mixture of such character as will be suitable for surfacing on the heaviest travelled highways. A sample of this oil-aggregate mix on a heavy travelled road was constructed in 1939 on US 12 between Battle Creek and Kalamazoo, as a resurfacing over an old concrete pavement. While the surface has been down too short a time to draw definite conclusions, there is every indication that if carefully designed, these mixtures are very durable.

The state highway department of Ohio has built from 75 to 100 miles of this type each of the past two years. While at first some difficulty was encountered in the use of slag-aggregate in this mix, there is every reason to believe that with heavier oil and perhaps a slightly different grading of the aggregate the slag would be as suitable as the gravel which is used so extensively in Michigan, or the limestone which has been used extensively by Hancock County, Ohio, on its county roads.

The city of Dayton, Ohio, has used this oil-aggregate mix in surfacing some of its secondary streets and for general repair work throughout the city. Bids received for the 1940 year's supply of various mixes dumped in the city trucks for repairing the city streets, were as follows:

Ohio State Highway Specifications

T-35 (Hot mix, 85-100 penetration asphalt	\$3.25 ton
T-50 (Hot mix, 50-70 penetration asphalt with aggregate grading more exact than in T-35).....	3.50 ton
T-60 (Cold mix, Amiesite type).....	3.80 ton
T-137 (Oil-Aggregate mix)	2.85 ton

These prices are perhaps quite indicative of the relative costs of producing the different plantmixes where all necessary grades of aggregate are about equally available.

The average cost of this oil-aggregate mix secured in 1940 by the Michigan State Highway Department on about 225 miles of this type was about \$2.85 per ton laid complete in place. This extremely low price was obtained by the highway department largely because of letting large contracts usually of not less than 10 miles of road. The Michigan State Highway Department is entitled to great credit from its taxpayers for so planning its work that these low unit prices are secured on its road work. As someone has defined the situation, it is a case of securing low wholesale unit costs as compared with the relatively high unit retail costs which



Fig. 7.—Showing a Rut in a Stone Shoulder of an Old 18 ft. Pavement. Altho Metal is Placed on This Shoulder the Traffic is so Heavy That a Rut is Constantly Formed Next to the Pavement. At a Very Nominal Cost a Bituminous Surface Can Be Constructed Next to the Old Pavement Which Will Eliminate the Rut

must prevail on small contracts especially when not in the vicinity of a permanent plant.

The city of Detroit also has used the oil-aggregate mix quite extensively as a surface for secondary streets and also for general repair work.

The lower cost at which the oil-aggregate mixture can be laid and the fact that it can be stored and used days and weeks or even months afterwards, probably accounts for this growing use for repair work.

CENTRAL HOTMIX PLANTS

Making Several Kinds of Bituminous Mixtures and Marketing Same to All Users Alike

In past years most hot mix plants made only one grade of mix, which was laid by the company operating the plant. This confined the use of the plant to the limited time when the company had a contract under construction. As a result many of the hot mix plants stood idle a greater part of the year.

Recently there has developed a hot mix plant set-up which does not do construction work but which sells and delivers bituminous concrete by the ton to anyone wanting it. Some of these plants have equipped themselves to make any of the various cold mix, hot mix and oil-aggregate mixes as their customers may require. One such plant furnishes a small 3 ton roller and operator at the rental price of \$1.50 per hour. This operator is an experienced high grade laborer who knows how to spread and roll the material, which is now used extensively for private drives, walks, playgrounds, parking areas and other miscellaneous purposes. By this means a property owner can have a private drive built to his garage for a very nominal sum.

Heavier Asphalts Used in Surface Treatments

In our enthusiasm over light cutback and emulsified asphalts which are quite liquid and workable after application to the road, we may have somewhat overlooked the desirability of soft asphalt cements and the heavy cutbacks for certain classes of work. The general impression for a while seemed to be that the more liquid products were to be preferred to insure best results. If traffic could be kept from the road a sufficiently long time we might say that these very liquid products would produce the desired surface. However, there is now such opposition to closing a road that for many roads these very liquid products are no longer suitable.

If a road is sufficiently smooth and does not need releveling, but only requires a protecting layer, then a surface treatment that will permit immediate traffic (after application) should be used. As examples of this type may be cited the soft asphalt cements used by the state highway departments of Florida and Texas. Texas generally uses a 120-150 penetration asphalt, while Florida uses a soft asphalt cement with a penetration of about 200. Ohio is using MC-5 cutback asphalt extensively in its heavy surface treatment work. This grade of cutback asphalt is substantially similar to the soft asphalt cements used by Texas and Florida in respect to results secured. Ohio has also experimented this year with 150 to 200 penetration asphalt in its surface treatment work.

All of these asphalts are sufficiently viscous that within a few minutes after covering with aggregate and rolling, traffic can use the surface without dislodging the particles.

Such treatments made with the use of these soft asphalt cements and heavy cutback asphalt not only reduce traffic interference to a minimum but they will last from 3 to 7 years without a retreatment. The lighter grades of cutback will continue to be used in both surface treatment and road mix, particularly where a road needs leveling by the dragging operations, but more lasting results will be secured for the same expenditure through the use of the heavier grades of asphaltic products.

It is imperative that properly sized aggregate as well as correct amount be used on these soft asphalt cements and heavy cutbacks to insure best results. This detail has now been worked out so that little difficulty is encountered in the production of a non-skid surface. In fact, a more completely non-skid surface should be possible over a period of years because of high per cent of aggregate exposed in the surface.

Salvage of Old Roads

Sometimes in the past cheap types of pavement have been constructed without regard for the increased traffic soon to come over them. Failure of these thin bases has often brought criticism of a surface type when the failure was due entirely to lack of sufficient foundation.

These "half-thickness" roads were frequently constructed because of lack of sufficient funds to construct a heavier pavement. Often they have served satisfactorily until heavier traffic demanded a stronger pavement. Now comes the necessity for decision as to the next step in the way of improvement. Shall it be salvage of the old pavement or replacement with a brand new



Fig. 8.—Filling Rut Along Edge of Old Narrow Pavement Preparatory to Widened Resurfacing Operation

one? In most cases the first alternative will be the correct one, and all the material now in place can be made to serve as a foundation for the new wearing course.

Many engineers have done a wonderful work in reclaiming old pavements by building a new piece of pavement here and there on a new location or grade, *but salvaging from 25 to 75 per cent of the old road*. Objections are sometimes offered that this class of work requires too much engineering. It is true that it does require more brain work on the part of the engineer but certainly not more than is justified when huge sums of money can be saved and the same transportation facilities secured. As someone has said, "Any fool can tear up an old pavement and build a new one—it takes a real engineer to plan a new pavement which will yet salvage the old pavement to the fullest extent warranted by alignment and grade."

Ruts along narrow pavements are hazardous to traffic. The presence of such a rut is proof that the pavement is too narrow. It is not costly to excavate a strip along the pavement with modern machinery and construct therein a stone or gravel base with bituminous treated surface, or a bituminous concrete top. Many miles of these narrow roads now are receiving such widened strip which is making them much safer for the modern high speed traffic.

National Defense

In connection with our National defense program, serious consideration should be given to the possible use of old roads in certain strategic locations before abandoning them.

In modern warfare, protection against bombing is proving one of the greatest problems. In many places a net-work of ordinary roads in the vicinity of military objectives would provide greater assurance of egress and ingress in case of an emergency, in place of one or two main boulevards that might be put out of commission with a few well placed bombs.

In very hilly and mountainous areas main roads are being relocated and justly so. However before destroying the old location beyond quick reconditioning, should we not give thought to the fact that the new road might be blocked and that the old road might again be useful?

The destiny of China may be determined by a single road. How different might be the history of that nation had there been alternate routes at some of the strategic points on the Burma Road?

A net-work of roads also serves to develop a much better community than can only one or two high speed boulevards. Hence, that plan which best fits in with our military program will also best serve the country in civil life. By reconditioning many of our old roads such a program for multiple highways can be economically developed.

CONTRACTOR PROVIDES LIFE INSURANCE FOR EMPLOYEES

Cornelius Vanderbilt, Jr., of West-New Brighton, S. I., N. Y., has provided group life insurance coverage for employees of road construction and repair companies of which he is president. The companies affected are the Vanbro Construction Corporation and the Road Material Corporation, both of West New Brighton.

The entire cost of the plan, which is being underwritten by the Metropolitan Life Insurance Co., is being

borne by Mr. Vanderbilt. Under the terms of the plan, general employees each receive \$1,000 life insurance. The plan also includes visiting nurse care and the distribution of pamphlets on health conservation and disease prevention.

STATE HIGHWAY CONSTRUCTION

The following reports were received too late for inclusion in the grouping on pages 62-84:

New York

State highway department expenditures in 1940 included the following: Highway construction, \$11,466,300; bridge construction, \$2,680,000; grade separation construction, \$5,890,600; maintenance, \$8,500,000. In addition \$700,000 was spent on equipment purchases. The highway construction completed in 1940 was as follows:

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed during 1940 (Miles)
Portland Cement Concrete.....	189.0
Sheet Asphalt	0.50
Bituminous Concrete	50
Bituminous Macadam	1
Bituminous Low Cost.....	24
Stone and Gravel (Untreated).....	1
Stabilized Construction	1
Graded and Drained Earth.....	14
Gravel (Bituminous Treated).....	58
Miscellaneous	3

New Mexico

Approximately 1,150 miles of all types of highway were constructed in 1940. The expenditure in that year was approximately \$6,750,000, this including construction, administration, maintenance and equipment. No figures are available at this time on the 1941 program. However, it is believed it will be about the same as in 1940.

Tennessee

Contracts completed in 1940 amounted to 111 miles and cost \$4,661,000. Possible mileage to be placed under contract in 1941 totals 227 miles at an estimated cost of \$9,626,000.

AUSTRALIA COMPLETES TRANSCONTINENTAL ROAD

Working day and night, teams of road-makers using the most modern plant have won a race against time, completing the 450-mile trans-continental road connecting the railhead at Birdum, 316 miles south of Darwin with the railhead at Alice Springs, 1,350 miles north of Adelaide.

The problem was to finish the job before the tropical rains compelled suspension of work. Engineers are confident that the road will withstand the tropical downpours which hitherto have isolated Darwin during the rainy season, except by the long sea route.

In addition to providing safe travel through the heart of the Continent, the new road gives access to broad belts of pastoral and mineral-bearing country, and facilitates speedy transport of cattle to the southern markets.

CONCRETE



Quantity of Concrete Pavement Placed Under Contract in 1940 Was Great for Any Previous Year Since 1932

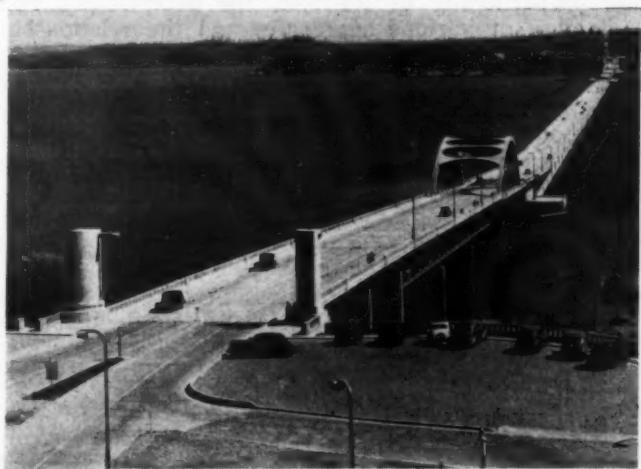
In Highway and Street Development

By C. M. BARBER

*Engineer, Highways and Municipal Bureau
Portland Cement Association*

INETEEN FORTY, just as previous years, has marked another milestone in progress, modernization and development. The widespread acceptance of concrete is exemplified in the part that it has played in the recent developments of our highway facilities—a part which, through the versatility of its uses, has added materially to the safety, the convenience, and the economic well being of the American public.

Experience, field experimental projects and research into the uses of concrete have provided developments which more than parallel the advances made in highway and street systems. These have all been made in sincere efforts to provide the greatest possible economies and benefits to the motor vehicle users.



The Lake Washington Floating Bridge at Seattle, Washington, Is Made of Concrete Pontoons Carrying a 4-Lane Roadway

Adaptability

Progress in concrete design and construction has involved research into unusual engineering problems. One of the most unique highway improvements of the past year has been the development and construction of the Lake Washington pontoon bridge at Seattle by the Washington Toll Bridge Authority. This project is a floating concrete structure composed of a series of reinforced concrete pontoons generally 350 feet long, 59 feet wide and 14 feet 3 inches deep. In effect they are cellular flat-bottom boats with sides and top and bottom slabs 8 inches thick, and with end walls, longitudinal frames, interior frames, and bulkheads 6 inches thick.

The use of concrete in such unusual construction is a significant example of its adaptability in meeting the needs of modernized highways. The lake crossing includes a length of 6,561 feet of bridge supported on pontoons and now provides a more direct route into Seattle as the travel distance has been shortened from the old route by a distance of 14 miles. A further example of the ingenuity of the engineers in economical use of concrete was the provision of a free channel by dividing a section of pontoons about 400 feet long into double two-lane instead of four-lane width, and retracting the four-lane section into open water between the two double-lane roadways.

Research

Significant are the efforts of the Public Roads Administration in furthering the most practical design principles in concrete pavements. Numerous surveys have indicated more or less definite relationships of the cracking of concrete pavements to fundamental design characteristics.



One of the White Portland Cement Concrete Cross Walks Which Is Typical of This Type of Safety Feature Placed at Many Intersections in Providence, R. I.

Joints.—Accordingly several experimental jointing projects have been initiated in typical states throughout the country. The purpose of this experimental work is to study the desirable spacing of transverse expansion joints in concrete pavements under closely controlled conditions of construction and scheduled observation. The projects are to include a study of the efficiency of dummy contraction joints with and without dowels or other devices for the transfer of load. The results from these observations are expected to establish a criterion for a still greater degree of efficient and economically adequate service.

The projects are expected to provide data concerning the following contentions:

1. Little or no provision for expansion is required in concrete pavements that have normal expansion characteristics provided that contraction joints are so spaced as to control cracking and are so maintained as to prevent the infiltration of solid materials.

2. When expansion joints are used it is not necessary to provide enough expansion space to effect complete relief of restraint but, on the contrary, it is desirable from a structural standpoint to provide only enough space to keep compressive stresses within safe limits.

3. In dummy-groove contraction joints, so spaced as to control cracking, it is unnecessary to use dowels or other load transfer devices, particularly when expansion joints are omitted or used only at long spacings.

The concrete mix on these projects was the standard



A Four-Lane Concrete Thoroughfare Near Buffalo, N. Y. The Permanent Traffic Lane Marks Are Made of White Portland Cement

of the state in which the project was built with the restriction that the coarse aggregate have a maximum size of not less than $1\frac{1}{2}$ inches. All expansion joints were $\frac{3}{4}$ inch wide with a non-extruding filler and with the exception of those on one section were provided with approved load transfer devices. Contraction joints were of the dummy-grooved type and the spacing reinforced sections was 15, 20 or 25 feet, depending on the type of aggregate and other local conditions.

Reports covering the details of three of these experimental jointing projects may be found in the 1940 Proceedings of the Highway Research Board.

Careful observations were made during construction so that a complete history of the project is available. Periodic inspections will be made to determine behavior in service, particularly with respect to any cracking that may develop. Measurements of pavement temperature and the longitudinal movement at expansion and contraction joints will be made at a number of selected points on the project. These measurements will be sufficiently comprehensive to establish the range of the daily and annual cycle of temperature change and slab movement.



Constructing the Black Magnetic Iron Oxide Center Stripe Developed by J. D. French, Texas Highway Department

Proportioning.—Extended field investigation and research also has been carried on during the year into the proportioning of concrete, the acceptability and suitability of various aggregates and the relationship thereof to the durability of the pavement. It is strikingly evident that careful selection of the aggregates and particularly the careful and proper proportioning and control of mixes is of vital importance if the maximum service, of which concrete is capable, is to be realized.

Pavers.—Developments in equipment for the construction of concrete pavements are noteworthy. Among the improvements in this field, the dual drum mixers, particularly in the 34E capacity, are outstanding. These dual drum mixers appreciably speed up production with a low relative increase in cost and power.

Safety

Many safety innovations are being currently incorporated into the design of concrete pavements. A brief review of several of these more outstanding features include the white cement cross walks which have been



Light Reflecting White Portland Cement Concrete Curb Adds to Safety of U. S. Route 22 in New Jersey. Black Cinder Concrete Slabs in Center Break Light

built in Providence, Rhode Island—one of the safest cities in the country. These street intersection cross walks are built integrally with the contrasting gray concrete of the streets and are of full sidewalk width. The white cross walks are made by bringing the street pavement up to within $1\frac{1}{2}$ inches of finished grade, then putting in white portland cement concrete made with white portland cement, silica sand and white marble chips.

Many miles of pavement have been built with permanent center stripes. Among these are traffic lane strips built with such materials as white portland cement concrete; black magnetic iron oxide impregnated into fresh concrete by a process patented by J. D. French, of the Texas Highway Department; colored aggregates, etc.

The highway departments in Tennessee and Kentucky have made interesting and practical application of one of the studies made possible through a correlation of the data available from the state-wide highway planning surveys. Studies have shown that even moderately loaded trucks cannot sustain a reasonable speed, commensurate with safety, on grades of any appreciable steepness. On sections of U. S. 31W in Tennessee and Kentucky, two important highway relocations have been recently completed and this annoyance to faster-moving vehicles has been eliminated. A third lane was built on hills, and the outside right lane was colored red. This red lane is designated for trucks and buses and slow-moving vehicles. The regular lane is then free for faster traffic on hills. In building the colored lane in Tennessee, red iron oxide was added to the mix for the top two inches of the pavement, while in Ken-

tucky the pavement was finished in a normal manner and the red iron oxide mixture then dusted over the pavement and floated into the surface. The efficiency of this type of design was readily apparent in the increased traffic capacity and freedom of vehicular movement on these sections.

The New Jersey Highway Department, which has pioneered in the development of light reflecting curbs for increased safety in night driving, has made remarkable progress in the refinement of this feature. These light reflecting curbs are precast of white portland cement concrete and have been installed on many miles of divided highways.

The constant and diligent efforts of the engineers, manufacturers and motor vehicle users throughout the country have been directed toward such progressive improvements to the economical, safe and easy riding qualities which are inherent in concrete pavements.

The most outstanding example of the thoroughly modern highway of today was completed during the past year. This achievement is the 160-mile limited way, Pennsylvania Turnpike, and is illustrative of the contribution which concrete is making to the highest type of present-day highway development.

This modern four-lane divided concrete highway is made up of two 24-foot lanes separated by a 10-foot dividing strip, except in tunnels where the highway narrows to two $11\frac{1}{2}$ -foot lanes. Open right of way is a minimum of 200 feet wide graded to a width of 78 feet. On fills there are two 10 foot berms between slope lines; in cuts the berms are 7 feet wide, with 3-foot drainage slopes outside the berms. Maximum grades do not exceed 3 per cent and horizontal curves, one to each mile on the average, are limited in the main to 4 degrees with only two at 6 degrees. The Turnpike is of significant military importance because of its strategic location and because of the adequacy of its design.

It is through such milestones of progress as these that the economic and social security of our country is assured.

MILEAGE OF FEDERAL-AID HIGHWAY SYSTEM

(December, 1939)

Alabama	4,152	Nevada	2,069
Arizona	2,357	New Hampshire	1,057
Arkansas	5,077	New Jersey	1,677
California	6,829	New Mexico	3,641
Colorado	3,721	New York	9,847
Connecticut	1,129	North Carolina	7,843
Delaware	825	North Dakota	7,193
Florida	2,764	Ohio	7,126
Georgia	6,482	Oklahoma	6,741
Idaho	3,372	Oregon	3,888
Illinois	9,512	Pennsylvania	8,151
Indiana	5,588	Rhode Island	549
Iowa	8,287	South Carolina	4,421
Kansas	8,883	South Dakota	6,314
Kentucky	3,820	Tennessee	4,676
Louisiana	2,766	Texas	14,678
Maine	1,681	Utah	2,232
Maryland	2,223	Vermont	1,094
Massachusetts	1,987	Virginia	4,694
Michigan	6,004	Washington	3,507
Minnesota	7,393	West Virginia	2,395
Mississippi	3,612	Wisconsin	5,795
Missouri	7,971	Wyoming	3,541
Montana	5,684	District of Columbia	81
Nebraska	5,731	Hawaii	622
		Puerto Rico	1,152
			232,834



A Portion of the Limited-Way Pennsylvania Turnpike

STATE HIGHWAY CONSTRUCTION

Reports from Highway Officials Showing Mileage Completed and Expenditures in 1940 and Probable Mileage and Expenditures in 1941

NEW ENGLAND STATES MAINE

One of the principal items in the 1940 state highway construction program was the completion of 301 miles of bituminous low cost pavement. Other items are shown in the tabulation.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$4,200,000	\$3,800,000
Bridge Construction	1,000,000	1,500,000
Grade Separation Construction	20,000	200,000
Maintenance	4,166,000	4,000,000
Equipment Purchases	67,137	60,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried Over to 1941 (Miles)
Bituminous Concrete	7	...
Bituminous Macadam	5	2
Bituminous Low Cost	301	4
Stone and Gravel (Untreated)	43	...
Bridges (Number)	50	...
Grade Separation (Number)	1	...

The construction program has not been completed for 1941, but it is estimated that 50 miles state highway, 100 miles state and gravel road, 100 third class gravel road of highway, 50 bridges and 2 grade separations will be put under contract.

NEW HAMPSHIRE

The state highway department is continuing its bridge construction program. Fifty-one bridges were completed in the construction program of 1940, and 30 more are listed in the 1941 program, plus 2 grade separations. The following tabulations give details of 1940 work and probable 1941 program:

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway, Bridge and Grade Separation Construction	\$2,447,138	\$1,976,000
Maintenance	3,315,616	3,380,000
Equipment Purchases	10,000	30,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)
Portland Cement Concrete	4.8
Bituminous Macadam	6.3
Bituminous Low Cost	80.0
Bridges (Number)	51
Grade Separation (Number)	3

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Portland Cement Concrete	8
Bituminous Concrete	12
Bituminous Low Cost	80
Bridges (number)	30
Grade Separation (number)	2

As in 1939 and 1940, the funds for maintenance in the 1941 program will exceed expenditures for construction purposes, the item on equipment purchases has been increased \$20,000 over 1940.

VERMONT

One of the principal items in the 1940 state highway construction program was the completion of 87 miles of surface treated gravel. Other items are shown in the tabulation.

STATE HIGHWAY EXPENDITURES

	Estimated Expenditures in 1940	Probable Expenditures in 1941	
Highway Construction (bridge and grade separation)	\$2,925,000	\$.....	Dependent on
Maintenance (St. Hwy. & St. Aid)	1,769,000	\$.....	Acts of Legislature
Equipment Purchases	43,000	\$.....	

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried Over to 1941 (Mi.)
Portland Cement Concrete	5.9	...
Bituminous Macadam	12.8	0.5
Bituminous Mix	41.4	6.0
Surface Treated Gravel	86.7	21.9
Bridges (number)	34	19
Grade Separation (number)	1	1

Since the state highway department is dependent

on the 1941 Acts of Legislature for highway funds no program is available at this writing for the coming year.

MASSACHUSETTS

The tables give information on the 1940 state highway department's construction program.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940
Highway Construction	\$1,301,156
Bridge Construction	
Grade Separation Construction	
Maintenance	3,547,563
Equipment Purchases	221,561

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Mi.)
Portland Cement Concrete	2.387	
Bituminous Concrete	6.076	5.012
Bituminous Macadam	11.286	13.697
Stone and Gravel (Untreated)	1.063	
Bridges (number)	7	16
Grade Separation (number)		7 Highway 2 R. R.

No information is available for the 1941 program of probable mileage to be constructed as this will depend upon appropriations by the 1941 legislature.

RHODE ISLAND

A total of 16 miles of highway construction and 2 bridges were completed under the 1940 program of the state highway department. Four of the 16 miles were dual type—portland cement and bituminous macadam. Mileage completed and carried over involved both 2-lane and 4-lane pavements. The following tables show state highway construction in 1940 and the probable work for 1941:

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$2,300,000	\$2,400,000
Bridge Construction	100,000	200,000
Maintenance	980,000	1,100,000
Equipment Purchases	175,000	225,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Mi.)
Dual Type—Portland Cement and Bituminous Macadam	4	5
Portland Cement Concrete	4	3
Sheet Asphalt	2	—
Bituminous Concrete	—	—
Bituminous Macadam	5	2
Bituminous Low Cost	1	—
Bridges (number)	2	1

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Dual Type—R. C. Conc. & Bit. Mac.	3
Portland Cement Concrete	5
Sheet Asphalt	3
Bituminous Macadam	5
Bridges (number)	1

MIDDLE ATLANTIC STATES NEW JERSEY

The approximate expenditures in 1940 for highway, bridge and grade separation construction were \$10,974,000. In addition \$2,535,958 was spent for right of way. The expenditure for maintenances were \$3,300,000 and for purchase of equipment \$310,000. The construction program for 1941 has not been decided. However, \$3,600,000 will be spent on maintenance and \$250,000 for equipment purchases.

Details of the 1940 state highway construction follow:

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried Over to 1941 (Miles)
Portland Cement Concrete	16.686*	31.473
Bituminous Concrete	0.697	1.521
Stone and Gravel (Untreated)	0.769	3.640
Graded and Drained Earth	27.599	13.228
Bridges (Number)	28	22
R. R. Grade Separation (Number)	4	1
Highway Grade Separation (Number)	1	11

* In addition 11.867 miles were widened.

EAST NORTH CENTRAL STATES

OHIO

Probable state highway construction program for 1941 includes 300 miles high type paving, 50 miles of low type paving and 80 bridges and grade separations. The probable expenditures are: \$13,500,000 for highway construction, \$5,000,000 for bridges and grade separations and \$11,000,000 for maintenance. It is expected to spend \$650,000 for equipment purchases.

INDIANA

The following information on state highway expenditures in 1940 is based on the fiscal year ended June 30, 1940:

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	*\$12,356,456	**\$16,411,000
Maintenance	4,500,400	4,500,000
Equipment Expenditures	38,922	x
Miscellaneous Service & Special Maintenance	4,209,670	3,000,000

*Includes bridge construction and grade separation. xNot available.

MILEAGE OF STATE HIGHWAY CONSTRUCTION COMPLETED IN 1940 AND UNCOMPLETED CONSTRUCTION CARRIED OVER TO 1941

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Miles)*
Hard Surface	171	100
Bituminous Types	140	87
Stone and Gravel (Untreated) (Includes Graded and Drained)	137	23
Rock Asphalt Resurfacing	199	35
Oil Mat and Surface Treatment	739	...
Dust Palliative	317	...
Bridges (number)	...	...
Grade Separation (number)	94	65

(x) About 75 miles of old pavement widened, part of which to be resurfaced.

*This work more than 50% complete. Mostly finished during calendar year, 1940.

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
High Type Paving	300
Low Type Paving	110
Stone and Gravel (Untreated)	14
Grading and Structures	290
Bridges (number)	162
Grade Separation (number)	162

ILLINOIS

Preliminary reports from the state highway department indicate that approximately \$27,350,000 will be expended in their 1940 construction program. Of this amount, construction cost is estimated at \$19,800,000 which includes highway construction, bridges, railroad grade separations and highway grade separations. Included in the 1940 program is \$5,250,000 of Federal aid work which has not been placed under contract, but will be advertised for letting during 1941. The probable funds for the 1941 program is estimated at \$27,500,000 of which \$20,000,000 is labeled for construction purposes. The latter figure excludes a possible allotment of \$5,782,000 from the Federal government. The state highway construction of 1940 and the partial program for 1941 are outlined in the table.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Construction	\$19,800,000	**\$20,000,000
Maintenance	6,350,000	6,500,000
Equipment Purchases	1,200,000	1,000,000

* Will have about \$25,782,000 available for new awards during 1941, but expect part of this will carry over into 1942.

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Mi.)
Pavement (includes Portland cement, concrete, brick on P.C.C. base, and bituminous surfaces on P.C.C. base)	167	91
Bituminous Surfacing (on gravel or crushed stone base)	112	52
Gravel or Crushed Stone Surfacing	86	87
Graded & Drained	104	55
Bridges	69	40
Railroad Grade Separations	18	9
Highway Grade Separations	2	1

PARTIAL MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941*

	Miles
Pavement (includes Portland cement concrete, brick on P.C.C. base, and bituminous surfaces on P.C.C. base)	36
Bituminous Surfacing (on gravel or crushed stone base)	0.40
Gravel or Crushed Stone Surfacing	12
Graded & Drained	8
Bridges	6
Railroad Grade Separations	10
Highway Grade Separations	2

*Includes work scheduled in current Federal aid programs not yet placed under contract.

WISCONSIN

Of the approximate expenditures of \$6,600,000 for construction work by the state highway department, \$2,621,000 of work will be carried over into 1941. De-

tails of the department's activities for 1940 are tabulated below:

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940
Highway Construction	\$5,500,000
Bridge Construction	700,000
Grade Separation Construction	400,000
Maintenance	3,000,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Amt.)
Portland Cement Concrete	50	\$ 92,000
Sheet Asphalt	0.2	.....
Bituminous Concrete	9.2	.....
Bituminous Low Cost	100	46,000
Stone and Gravel (Untreated)	86	145,000
Graded and Drained Earth	112*	1,080,000
Bridges (number)	40*	.....
Grade Separation (number)	5*	1,258,000

*All but 30 miles of this was also surfaced.

Details of the 1941 construction program are not yet available.

MICHIGAN

Approximate expenditures for highway construction for 1940 totaled \$22,600,000. Probable expenditures for 1941 is estimated at \$18,613,000. Equipment purchases by the department are for maintenance only. The tables show 1940 work and the probable construction program for 1941.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$12,900,000	\$9,776,000
Bridge Construction	1,675,000	1,022,000
Grade Separation Construction	875,000	980,000
Maintenance	6,900,000	6,515,000
Equipment Purchases	250,000	320,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Mi.)
Portland Cement Concrete	231	Not determined
Brick and Asphalt	3	" "
Sheet Asphalt	None	" "
Bituminous Concrete	7	" "
Bituminous Low Cost	904	" "
Stabilized Construction	224	" "
Graded and Drained Earth	76	" "
Bridges (number)	51	" "
Grade Separation (number)	11	" "

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Portland Cement Concrete	83
Bituminous Low Cost	530
Stabilized Construction	82
Graded and Drained Earth	12
Bridges (number)	21
Grade Separation (number)	4

In addition to the probable mileage of state highway construction program for 1941, a certain percentage of 1940 work can be expected to be carried into the new year.

WEST NORTH CENTRAL STATES MINNESOTA

The approximate expenditures for the 1940 highway program by the state highway department listed below do not include the month of December. Right of way expenditures are also omitted.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$7,772,000	\$9,782,000
Bridge Construction	1,114,000	.....
Grade Separation Construction	153,000	2,192,000
Maintenance	4,892,241	6,985,772
Equipment Expenses	388,000	310,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Mi.)
Portland Cement Concrete	54	1
Brick	2	.....
Bituminous Concrete	.....	.....
Bituminous Macadam	276	54
Bituminous Low Cost	.....	.....
Stone & Gravel (Untreated)	204	95
Stabilized Construction	254	54
Graded & Drained Earth	282	72
Bridges (number)	37	31
Grade Separation (number)	2	2

Since the state highway department have not as yet formulated the 1941 program, details of mileage to be put under construction are not available. However, from the comparative tables above on funds expended in 1940 and probable funds available for 1941, the increase of \$4,950,531 over 1940 funds would indicate an expansion of highway work.

MISSOURI

During 1940, the efforts of the state highway department commission were largely diverted toward increasing road safety by modernization and improvement of the present system and the extension of farm-to-market roads as far as funds would permit. It is planned that this policy will be continued in 1941. All possible consideration will be given to roads which have been designated as military roads and strategically important to national defense.

The following figures are for contracts awarded in 1940 (to December 10th) and the present estimates for awards in 1941.

1940 AWARDS TO DEC. 10

	Miles
Graded and Drained (unsurfaced)	99
Agg-Clay Stabilization	29
Granular	196
Bituminous	245
P. C. Concrete	164

Contract cost + 10% \$13,581,200. This figure represents contract miles. Allotment for maintenance was \$5,600,000.

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Portland Cement Concrete	110
Bituminous	206
Graded and Drained Earth	29
Granular	222

It is estimated that the anticipated road construction for 1941 will cost about \$10,660,000. Funds for maintenance and equipment are not available.

Missouri is now on a pay-as-you-go-basis and all federal funds have been matched up to the 1941 allotment. Heavy bond requirements and maintenance of the system necessarily curtail the funds available for construction. An accurate estimate of work on strategic highways in 1941 is impossible, due to defense installations which are now being started and the uncertainty of future demands.

NORTH DAKOTA

State highway expenditures in 1940 included \$4,067,000 for construction, \$1,389,000 for maintenance, and \$75,000 for equipment. It is expected that \$4,900,000 for construction, \$1,610,000 for maintenance and \$100,000 will be available for highway construction in 1941.

Work completed in 1940 included 179 miles of low cost bituminous mix and five grade separations. Uncompleted work carried over to 1941 include 27 miles of low cost bituminous mix and one grade separation.

Probable construction program for 1941 will include 290 miles of low cost bituminous mix, 1 bridge and 4 grade separations.

SOUTH DAKOTA

The following tabulations give some details of the state highway construction for work accomplished in 1940 and the probable program for 1941.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$3,523,700	\$3,325,000
Bridge Construction	688,300	600,000
Grade Separation Construction	53,000	75,000
Maintenance	2,300,000	1,900,000
Equipment Purchases	90,000	100,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Mi.)
Portland Cement Concrete	11,618	.....
Bituminous Low Cost	111,458	.....
Stone and Gravel (untreated)	81,084	32,652
Graded and Drained Earth	306,564	187,889
Bit. treated gravel base course	81,475	34,664
Flashing light signals	12	.....
Bridges (number)	73*	27
Grade Separation (number)	2	2

* In addition 6 bridges were widened.

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)	Widening (Miles)
Portland Cement Concrete	7,976	....
Bituminous Low Cost	35,903	....
Stone and Gravel (untreated)	60,000	....
Graded and Drained Earth	300,000	....
Bit. treated gravel base course	303,149	....
Seal on base course	212,305	....
Flashing Light Signals	12	....
Bridges (number)	65*	10
Grade Separation (number)	3	....

*In addition 10 bridges will be widened.

From the tables above, it is apparent that the state highway department's program for 1941 will be similar to the 1940 program.

NEBRASKA

The estimated state highway expenditures in 1940 were \$7,825,000 for highway, \$700,000 for bridge, \$475,000 for grade separation and \$2,680,000 for maintenance, totaling \$11,680,000. The mileage of highway construction completed during 1940 and uncompleted and carried over to 1941 is given below:

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Mi.)
Portland Cement Concrete	17	3
Bituminous Low Cost	606	97
Stone and Gravel (untreated)	184	25
Graded and Drained Earth	47	90
Bridges (number)	123	57
Grade Separation (number)	6	3

The construction program for 1941 has not been completed, but the probable expenditures for highway work is estimated at \$5,665,000 for construction which includes roadway, bridges and grade separations. Expenditures anticipated for maintenance is set at \$3,000,000.

KANSAS

State highway expenditures for the 1940 program totalled \$12,382,000. Probable expenditures for 1941 is set at \$11,071,000. Details are tabulated below:

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway, Bridge & Grade Separation Construction (lump sum)	\$8,822,000	\$7,630,000
Maintenance	3,310,000	3,225,000
Equipment Purchases	250,000	216,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed to 11-30-40 (Miles)	Uncompleted on 12-1-41 (Miles)
Portland Cement Concrete	24.3	24.7
Bituminous Low Cost	528.8	245.0
Stone & Gravel (untreated)	152.9	183.6
Graded and Drained Earth	169.8	273.8
Bridges (number)	53	82
Grade Separations (number)	7	5

The construction program for 1941 has not been definitely completed. However, indications are that the commission will probably do the usual amount of each type of construction as they did during the past year.

SOUTH ATLANTIC STATES
DELAWARE

A total of 275 miles of highway construction, 6 bridges, and 1 grade separation were completed by the state highway department during the 1940 program. Details are given below and include the probable program for 1941.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$1,256,000	\$1,500,000
Bridge Construction	188,500	160,000
Grade Separation Construction	74,000	270,000
Maintenance	1,200,000	1,000,000
Equipment Purchases	65,500	65,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)
Portland Cement Concrete	17*
Bituminous Concrete	...
Bituminous Low Cost Surface Treatment	200
Stone and Gravel (untreated)	25
Stabilized Construction	8
Graded and Drained Earth	25
Bridges (number)	6
Grade Separation (number)	1

*In addition 11 miles of concrete road were widened.

PROBABLE MILEAGE OF STATE HIGHWAY
CONSTRUCTION IN 1940

	Full Width Construction (Miles)
Portland Cement Concrete	3*
Sheet Asphalt	1
Bituminous Concrete	23
Bituminous Low Cost	200*
Stone and Gravel (untreated)	19
Graded and Drained Earth	20
Bridges (number)	3
Grade Separation (number)	2

*In addition 37 miles of concrete road will be widened.

Included in the 17 miles of portland cement concrete construction completed during 1940 are 11 miles of concrete base construction for bituminous concrete surface. Similar treatment will be introduced in part of the concrete paving scheduled for 1941.

MARYLAND

State highway expenditures in 1940 included \$5,513,701 for highway construction and \$4,298,447 for grade separation construction. The following tabulation summarizes the expenditures in 1940 and the probable expenditure in 1941.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$5,513,701	\$5,078,200
Bridge Construction	1,215,254	2,783,000*
Grade Separation Construction	4,298,447	...
Maintenance	3,922,476	4,534,470x
Equipment Purchases	414,000	...

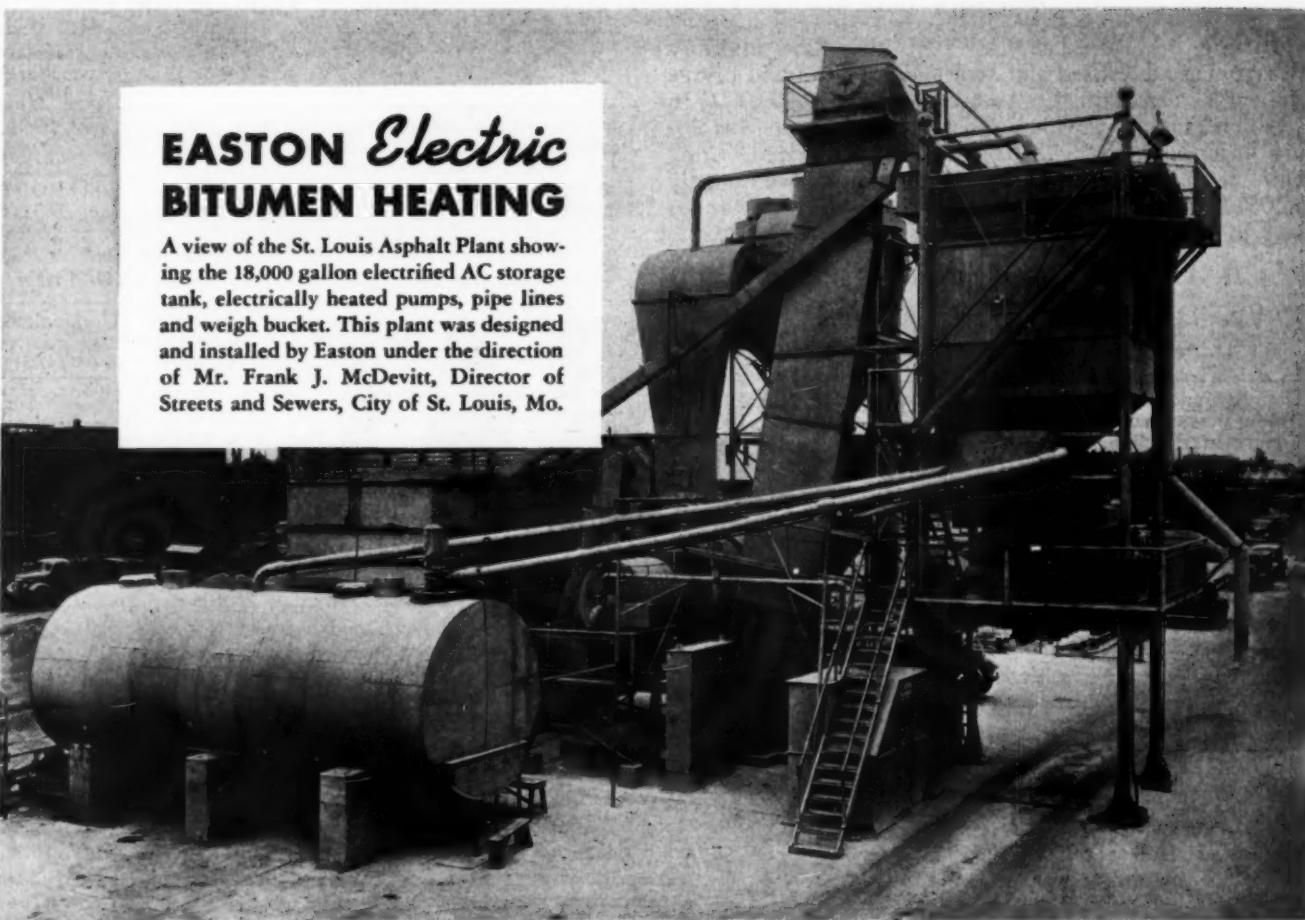
*Includes grade separation construction. xIncludes \$844,000 for county maintenance.

MILEAGE OF STATE HIGHWAY CONSTRUCTION
COMPLETED IN 1940

	Completed During 1940 (Miles)
Portland Cement Concrete	11.72
Bituminous Concrete	0.60
Bituminous Macadam	1.12
Bituminous Low Cost	5.34
Stone and Gravel (untreated)	8.41
Stabilized Construction	11.47
Graded and Drained Earth	10.45

PROBABLE MILEAGE OF STATE HIGHWAY
CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Portland Cement Concrete	36.0
Bituminous Macadam	40.5
Bituminous Low Cost	20.4
Stone and Gravel (untreated)	37.4
Stabilized Construction	31.9
Bridges (number)	3
Grade Separation (number)	7



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VIRGINIA

During the calendar year 1940 the state highway department advertised and awarded 113 road and bridge contracts, amounting to approximately \$10,500,000. In addition, 33 convict labor construction projects, involving approximately \$4,250,000, were authorized, along with 38 miscellaneous projects totaling approximately \$1,031,000. This gives a grand total of work put under way in 1940 of \$15,781,000. Details are given below.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway and Bridge Construction	\$14,166,526	\$26,136,161
Grade Separation Construction	113,438	372,000
Equipment Purchases		300,000

No information is available for allotments for maintenance and equipment purchases for 1940. Expenditures in these items are included in highway construction funds. Maintenance funds for 1941 are also included in probable expenditures for 1941.

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Widened During 1940 (Mi.)	Uncompleted Carried over to 1940 (Mi.)
Portland Cement Company	1	23	4
Bituminous Concrete	1	31	13
Bituminous Macadam	103	28	51
Stone & Gravel (untreated)	21	---	7
Graded and Drained	36	---	8
Surface Treatment Soil and Gravel	124	31	23
Dual Type (Bit. & Conc.)	---	34	8
Flash Light Signals	7	---	10
Bridges (number)	29	---	5
Grade Separation (number)	3	---	1

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941-1942

	Full Width Construction (Miles)	Widening (Miles)
Portland Cement Concrete	24	41
Brick	---	---
Sheet Asphalt	---	---
Bituminous Concrete	---	17
Bituminous Macadam	203	11
Bituminous Low Cost	---	---
Stone and Gravel (untreated)	---	---
Stabilized Construction	---	---
Graded and Drained	2	---
Surface Treatment Soil & Gravel	42	---
Bridges (number)	---	8

Since the highway department functions under a fiscal year policy which begins July 1st each year, the completed and uncompleted work as indicated in the table of mileage of state highway construction is in reality a one year program which began July 1, 1940, and will end June 30, 1941.

The probable funds and mileage of construction is for the fiscal year July 1, 1941 - July 1, 1942.

WEST VIRGINIA

The expenditures for construction under the direction of the state road commission in 1940, including the carry-over from 1939, will approximate \$13,860,534. Details of completed work for 1940 and mileage carried over to 1941 are shown in the tables.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940
Highway Construction	\$7,809,905
Bridge Construction	529,629
Grade Separation Construction	221,000
Maintenance	4,800,000
Equipment Purchases	500,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Mi.)
Portland Cement Concrete	19	16
Bituminous Concrete	76	16
Bituminous Macadam	86	56
Stone and Gravel (untreated)	14	16
Stabilized Construction	8	---
Graded and Drained Earth	105	77
Surface Treatment	566	4
Guard Rail	44	---
Bridges (number)	14	4
Grade Separation (number)	5	2

In addition 5 miles of bituminous concrete and 18 miles bituminous macadam were widened.

It is anticipated that substantially the same allocations for primary and secondary maintenance and construction will be made for the calendar year of 1941 as in 1940.

The 1941 forecast for primary construction is estimated at \$7,986,000, and for secondary construction at \$1,540,200. These estimates include both programmed and suggested work for contract. Suggested work for contract requires legislative confirmation before it can be put into effective construction work. Schedule below shows probable construction program for next year.

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Primary (Miles)	Secondary (Miles)
Grading and Draining (programmed)	69	26
*Grading and Draining (suggested)	51	20
Bituminous Surface (suggested)	200	200
*Macadam and Bituminous (programmed)	43	3
Roadside Development (programmed)	6	---
Roadside Development (suggested)	10	---
Flashing Crossing Signals (programmed)	6	---
Flashing Crossing Signals (suggested)	8	---
Bridges (programmed)	13	6
Bridges (suggested)	12	10

*Included in the totals are 15 miles of grading and draining, and 30 miles of bituminous macadam suggested for prison labor construction.

NORTH CAROLINA

Of the total \$23,495,000 expenditures by the state highway department during 1940, \$12,500,000 was expended for maintenance. Probable funds for 1941 have been increased \$2,405,000 over last year's, and the rearrangement of allocations will provide \$15,500,000 for maintenance. Details are given in the tables.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$ 7,975,000	\$ 7,550,000
Bridge and Grade Separation Construction	2,320,000	2,150,000
Maintenance	12,500,000	15,500,000
Equipment Purchases	700,000	700,000



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MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Widened During 1940 (Mi.)	Uncompleted Carried over to 1941 (Mi.)
Portland Cement Concrete	54	185	46
Sand Asphalt	25	22	
Bituminous Macadam	98	—	50
Bituminous Low Cost	182	—	64
Graded and Drained Earth (only)	62	—	47
Bridges and Separations (number)	110	—	60

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)	Widening (Miles)
Portland Cement Concrete	50	160
Sand Asphalt	15	20
Bituminous Macadam	75	—
Bituminous Low Cost	140	—
Graded and Drained Earth (only)	90	—
Bridges and Grade Separations (numbers)	60	—

SOUTH CAROLINA

The road building program of the state highway department proceeded in 1940 at about the same pace that it did during previous years. Contracts awarded in 1940 totalled \$8,512,000. Actual expenditures for the calendar year were approximately \$7,950,000.

Maintenance expenditures for the fiscal year ending June 30, 1940, totalled \$3,357,051. Of this expenditure, \$1,652,892 was spent for the direct cost of maintenance, \$700,351 for retreatment, \$481,663 for shoulder treatment, \$1,965 for special maintenance, and \$520,178 for the purchase of new equipment.

The state highway system comprises about 9,642 miles of which about 6,550 miles are now hard surfaced. During the past three years, at the rate of 1,000 miles per year, 3,000 miles have been added to the system through legislative action. This addition approximately equals the number of miles of road in the system which are not hard surfaced.

A classification of the miles on the state highway system by types, as of Oct. 31, 1940, is as follows:

	Type	Miles
Completed:	Standard High Type Pavements	2,611.45
	Bituminous Surface Treatments	3,828.10
	Earth Types	150.99
		6,590.54
Under Construction:	Standard High Type Pavements	9.17
	Bituminous Surface Treatments	161.94
	Earth Types	111.00
		282.11
Unimproved		2,769.77
Total Miles		9,642.42

It is anticipated that expenditures for construction and maintenance operations in 1941 will be at about the same level as 1940.

GEORGIA

The following is an unofficial estimate of the highway expenditures:

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction, Bridge Construction and Grade Separation	\$15,572,786	\$15,000,000
Maintenance	1,675,271	1,500,000
Equipment Purchases	2,718,070	500,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Let to Contract or Placed Under Construction (Miles) in 1940
Portland Cement Concrete, Brick, Sheet Asphalt, Bituminous Concrete and Bituminous Macadam	125
Bituminous Low Cost	1,478
Stone and Gravel (Untreated)	870
Graded and Drained Earth	759

The detailed construction program for 1941 had not been decided.

EAST SOUTH CENTRAL STATES
KENTUCKY

Of the 558 miles of roadway constructed by the state highway department in 1940, hard surfaced roads totalled 181 miles, bituminous 192 miles and graded and drained 185 miles. Details of 1940 work are given below and include funds available for 1941.

STATE HIGHWAY EXPENDITURES

	Actual Expenditures 1940	Estimated Expenditures 1941
For Construction	\$11,000,000	\$10,000,000
For Maintenance	5,500,000	6,000,000
For Equipment	425,000	400,000
Totals	\$16,075,000	\$16,400,000

MILEAGE OF CONSTRUCTION COMPLETED IN 1940

	Constructed in 1940
Hard Surface (concrete, rock asphalt and bituminous concrete)	(a) 181 miles
Bituminous Types (surface treatment—surface mix and stabilized base)	192 miles
Graded and Drained (including traffic bound macadam and gravel surfacing)	185 miles
Bridges (number)	(b) 16
(a) Includes 13 miles of extra width paving.	
(b) Includes 3 railroad overhead crossings.	

ALABAMA

Since the state highway department operates on a fiscal year policy which ends on 30 of September of each year, a definite demarcation of construction work with each calendar year is not available.

During the fiscal year ending Sept. 30, 1940, the following construction work was accomplished.

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed in 1940 (Miles)
Bituminous Construction:	
Mat	408
Liquid Seal	138
Plantmix Seal	280
Grading and Draining	647
Temporary Surfaces	85
Miscellaneous	10
Bridges (number)	3

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It is estimated that there will be a slight decrease of mileage in the various types of road construction for the year ending September 30, 1941. The estimated total of funds available is \$16,116,000, of which \$8,300,000 will be absorbed for highway construction, \$2,500,000 for maintenance, and \$300,000 for purchase and replacement of equipment.

MISSISSIPPI

Expenditures by the state highway department is estimated at \$17,888,262 for 1940. Preliminary estimate for probable expenditures for 1941 total \$4,188,400. As shown in the tables below considerable amount of work scheduled for 1940 will be carried into 1941 for completion.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction, Bridge Construction and Grade Separation		
Construction	\$15,631,689	\$2,313,400*
Maintenance	2,056,573	1,800,000
Equipment Purchases	200,000	75,000

*Includes projects definitely programmed.

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried over to 1941 (Mi.)
Portland Cement Concrete	83.6	87.5
Bituminous Concrete	1.1	1.0
Bituminous Low Cost (Surf. Treat.)	189.6	225.0
Graded and Drained Earth	484.4	156.0
Sand Asphalt	65.8	36.8
Roadside Improvement	9.1	1.3
Gravel	11.2	1.2
Bridges (number)	202	77
Grade Separation (number)	5	9

No definite mileage program has as yet been established for new work for 1941. A preliminary draft, however, indicates that 111 miles of various types of hard surfaced roads and 57 miles of graded and drained earth roads are being considered.

WEST SOUTH CENTRAL STATES ARKANSAS

The construction program for the 1940 calendar year was financed with federal funds made available through toll bridge reimbursement accomplished by action of the state in freeing all state-owned and operated toll bridges in the spring of 1938. The funds involved were in the following amounts.

Regular Federal Aid	\$1,955,000
Secondary Federal Aid	255,000
	\$2,210,000

In addition, carry over balances accrued sufficient in amount to allow contract commitments to be made in the total of \$3,022,841. These funds provided for work of the following general classification, grading and minor drainage structures being a necessary appurtenance to many of the projects involved.

Grade Crossing Separation and Protection funds apportioned to the state from federal sources, and not requiring matching, amounted to \$510,000. This sum, together with accrued balances allowed contract commitments in the total of \$775,998, thus financing the construction of five separation structures, two relocat-

tion projects and twelve railroad crossing protection devices.

MILEAGE OF STATE HIGHWAY COMMISSION

	Completed in 1940
Pavement, High Type	15 miles
Bituminous Surfacing, Road Mix or equivalent	125 Miles
Untreated Gravel Surfacing	28 miles
Major Bridges	4,013 lin. ft.

Expenditures for the probable construction program for 1941 are not available.

LOUISIANA

The value of work now under construction which will be carried forward to 1941 is \$6,535,300 and the funds available for new construction in 1941 amount to \$18,281,675, of which \$5,900,000 is United States Government funds for the construction of bridges in the floodway area; and approximately \$4,800,000 is Works Projects Administration funds for highway work. These federal funds are available from previous allotments. Details of the 1940 work and new work for 1941 are given below:

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed 1940	Forward to 1941
Concrete	40	\$ 1,829,400
Surf. Treat.	19	205,500
Gravel	173	1,154,900
Grading	50	1,180,300
Bridges	3	4,917,600
Grade Sep.	1	576,300
Roadside Imp.	9	55,800
Surf. Tr. Imp.		
	304	\$ 9,919,800
Maint. Const.	427	1,198,890
	731	\$11,118,690
		423
		\$6,469,300
		24
		66,000
		447
		\$6,535,300

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Mileage	Cost
Concrete	47	\$ 2,108,000
Surface Treat.	45	878,000
Gravel	356	3,141,000
Grading	33	2,572,000
Bridges		5,400,000
Grade Separation		463,000
Road Improvement	260	1,206,000
Surface Treatment Improvement	583	2,513,675
	1,324	\$18,281,675

In addition to the \$18,281,675 available for new highway construction in 1941, \$3,500,000 for maintenance and \$250,000 for equipment have been included in the highway budget. The equipment funds will provide additional purchases to supplement state owned equipment valued at \$3,000,000.

The principal features of the 1941 program will be the completion of the highway between the Mississippi River bridge at Baton Rouge and Nesser, including a connection with Baton Rouge; the widening of the pavement between Bonnet Carre spillway and Kenner; the paving of the highway between the Mississippi River bridge at New Orleans and Boutte; the paving of the highway between Shreveport and Caddo Lake; the paving of the relocation between Lee and Michaud and the completion of numerous flood control projects.

New work to be undertaken in 1941 will be paving of the highway between Nesser and Prairievile and

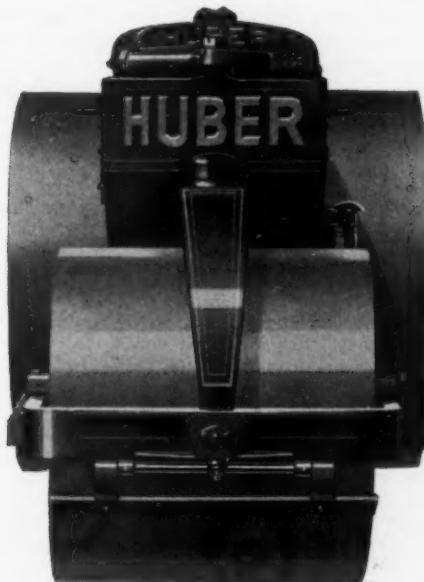
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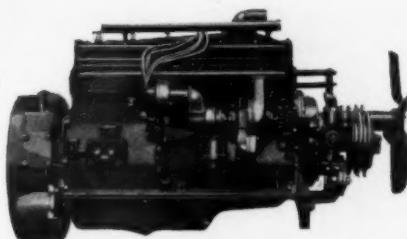
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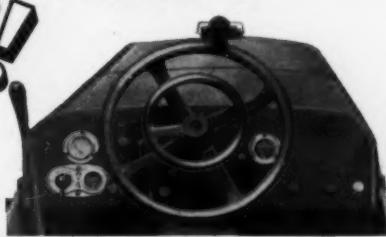
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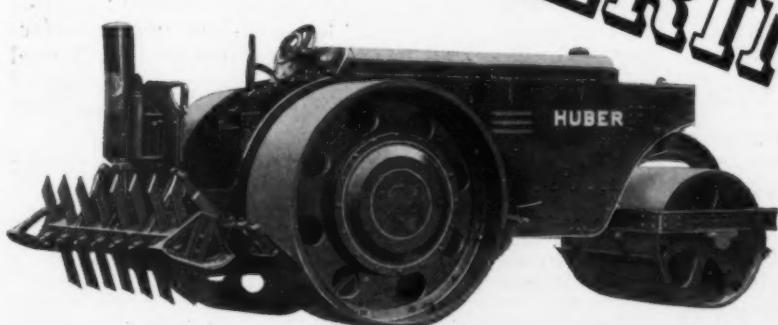
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the widening of the pavement between LaPlace and the Bonnet Carré spillway on the airline highway; the paving of approximately nineteen miles on the Alexandria-Columbia highway; the widening of the pavement between Kingsville and Camp Livingston; the construction of numerous bridge and railroad grade separation structures; the construction of approximately 33 miles of concrete pavement; 45 miles of surface treatment; 356 miles of grading and surfacing; 260 miles of roadside improvement and 583 miles of improvement along concrete and bituminous highways.

TEXAS

The state highway department closed its books for another fiscal year on Aug. 31, 1940, completing 786 projects, including 61 large bridges and 23 grade separations at a total cost of \$38,589,117. Contracts awarded for 743 projects during the year were estimated at \$28,020,989. Details of work completed during the fiscal year are shown in the table below:

Type	Mileage	Cost
Grading and Small Structures.....	516	\$ 5,892,639
Gravel, Caliche, etc. Surface.....	682	8,080,845
Asphalt Surface.....	1,302	9,110,975
Concrete.....	126	4,313,000
Railroad Relocation.....	.....	32,313
Highway Protecting Devices.....	.....	1,379,045
Landscape Projects.....	.....	303,482
 Total Highways.....	2,626	\$29,112,303
Large Bridges.....	.....	\$ 6,948,439
Underpasses and Overpasses.....	.....	2,528,374
 Grand Total.....	.....	\$ 9,476,814
 Grand Total.....	.....	\$38,589,117

An Aug. 31, 1940, there were 473 projects, including 36 large bridges and 13 grade separations, under construction and active, though part of the cost shown had been paid on estimates prior to Aug. 31:

Type	Mileage	Cost
Grading and Small Structures.....	159	\$ 1,316,510
Gravel, Caliche, etc. Surface.....	507	4,05,929
Asphalt Surface.....	851	7,723,292
Concrete.....	100	3,094,653
Highway Protecting Devices.....	.....	129,165
Highway Planning Survey.....	.....	556,327
Landscape Projects.....	.....	26,949
 Total Highways.....	1,617	\$16,896,828
Large Bridges.....	.....	\$ 1,533,323
Underpasses and Overpasses.....	.....	1,505,569
 Grand Total.....	.....	\$ 3,038,892
 Grand Total.....	.....	\$19,935,721*

*Includes 135 joint state highway-WPA projects totaling 477 miles on which labor is furnished by WPA.

During the year an average of 8,216 persons were carried on the pay rolls of the department, performing engineering, maintenance and other work necessary to the efficient operation of the highway department, and these persons received \$10,286,196.05 in payment for their labor. In addition, there was an average of 6,882 persons employed by contractors engaged on state highway contracts, and it is recognized that for every person actually engaged in highway construction, there are three others engaged in the production and transportation of materials and equipment.

MOUNTAIN STATES MONTANA

Approximate expenditures, complete and uncompleted mileages for 1940, and the probable program for 1941 for the state highway department are shown in the tables below:

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$5,316,600	\$4,900,000
Bridge Construction	667,400	700,000
Grade Separation Construction	276,000	100,000
Maintenance	1,880,000	1,940,000
Equipment Purchases	264,000	260,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried Over to 1941 (Miles)
Bituminous Low Cost.....	83	97
Stone and Gravel (Untreated).....	161	203
Stabilized Construction	10	12
Graded and Drained Earth.....	84	192
Bridges (number)	29	43
Grade Separation (number)	0	1

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Po-tland Cement Concrete	1
Bituminous Low Cost	140
Stone and Gravel (Untreated).....	225
Graded and Drained Earth.....	210
Bridges (number)	97
Grade Separation (number)	3

IDAHO

The approximate expenditures during 1940 for highway construction amounted to \$3,110,000. This amount includes cost of constructing 7 bridges and 2 grade separation projects. The maintenance expenditures will approximate \$1,510,000 and our equipment purchases amounted to \$30,000, a grand total of \$4,650,000 for the year.

The mileage completed during 1940 follows: grading and surfacing, 113 miles; low-cost bituminous surfacing, 235 miles; and .5 mile of concrete paving. A total of 70 miles of grading and surfacing and 12 miles of plant mix bituminous surfacing contracted during 1940 will be carried over to 1941.

The probable expenditures for state highways during 1941 follow:

Construction	\$3,638,000
Maintenance	1,600,000
Equipment Purchases	100,000

The construction expenditures will include approximately 108 miles of grading and surfacing, 144 miles of low-cost bituminous surfacing, 9 miles of concrete pavement, and one steel and concrete bridge.

WYOMING

Among the items of construction of the state highway department was the construction of 300 miles of bitu-

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minous low cost armor coat. Of the 30 bridges in the 1940 program, 10 will be carried over to 1941 for completion. Approximate expenditures for 1940 total \$5,150,000. Probable funds for 1941 is estimated to be \$4,450,000. Details of the 1940 work and the probable construction program for 1941 are given below:

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$4,300,000	\$3,600,000
Maintenance	750,000	750,000
Equipment Purchases	100,000	100,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried Over to 1941 (Miles)
Bituminous Low Cost	160	40
Graded and Drained Earth	100	50
Bituminous Low Cost Armor Coat	300	...
Bridges (number)	30	10
Grade Separation (number)	0	3

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Bituminous Low Cost	300
Grade Separation (number)	2
Graded and Drained Earth	150

ARIZONA

The table gives information on 1940 work and probable 1941 program of the state highway department.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction (includes bridge construction)	\$5,047,650	\$4,477,000
Grade Separation Construction	106,835	186,252
Maintenance and Betterments	1,207,634	1,500,000
Equipment Purchases	1,187,948	1,225,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried Over to 1941 (Miles)
Portland Cement Concrete	7	2
Bituminous Low Cost	209	48
Stone and Gravel (Untreated)	5	3
Grade Separation (number)	1	...
Graded and Drained Earth	8	5

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Bituminous Concrete	10
Bituminous Low Cost	270
Stone and Gravel (Untreated)	280
Graded and Drained Earth	180
Bridges (number)	6
Grade Separation (number)	1

Funds for equipment purchases listed above are capital accounts which include equipment and overhead.

COLORADO

The construction program for 1940 of the state highway department involved the expenditure of approximately \$5,400,000 and \$1,500,000 for maintenance. Equipment purchases are chiefly for the maintenance department and are paid for out of the maintenance appropriation. It is estimated that the probable expenditures for 1941 program will amount to \$7,000,000. The following tables give some details of the 1940 work and probable work for 1941.

STATE HIGHWAY EXPENDITURES FOR 1940 AND 1941

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction and Bridges and Oiling	\$5,050,000	\$5,000,000
Grade Separation Construction	350,000	500,000
Maintenance	1,315,000	1,315,000
Equipment Purchases	185,000	185,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Uncompleted Carried Over to 1941 (Miles)
Bituminous Low Cost	442.0*	115.0
Stone and Gravel Surfacing	115.0	85.0
Grade Separation (number)	7	8

*In addition 88 miles of highway were widened.

The item, 88 miles of widening, involved the laying of strips of oil mat, 4 feet wide, along the shoulders of concrete pavement. This widened the driving surface from 18 feet to 26 feet.

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Bituminous Low Cost	500*
Stone and Gravel Surfacing	115
Grade Separation (number)	5

*In addition 90 miles of highway will be widened.

When the 1940 budget was prepared a year ago, there remained \$1,378,547 of federal aid that the state was unable to match. However, subsequent negotiation pared down the unmatched funds to \$709,279. This was accomplished by securing approval of the U. S. Public Roads Administration on the oil specification developed by the state highway department for the oiling of highways. As a result, for the first time, the department was able to use federal aid funds in the oiling of highways. An early report indicates that unmatched funds for 1941 will probably come within \$500,000.

UTAH

State highway expenditures in 1940 for highway construction, bridge and grade separation was approximately \$3,000,000. In addition \$1,200,000 went for maintenance and \$280,000 for equipment purchases. The probable expenditures in 1941 for construction is \$2,550,000, for maintenance \$1,500,000 and for purchase of equipment \$300,000. The following table gives details of the 1940 construction:



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MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Widened During 1940 (Miles)	Uncompleted Carried Over to 1941 (Miles)
Portland Cement Concrete.....	0.4	6.3	2.4
Rock Asphalt	6.7	...	...
Bituminous Low Cost.....	136.8	4.2	35.9
Stone and Gravel (Untreated)	44.9	5.6	37.9
Graded and Drained Earth.....	6.7	32.8	17.6
Landscape Projects	23.7	...	31.3
Bridges (number)	16	7	...

The following tabulation gives some details of the 1941 program:

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Construction (Miles)
Portland Cement Concrete.....	14
Rock Asphalt	5
Bituminous Low Cost	100
Stone and Gravel (Untreated)	80
Graded and Drained Earth.....	35
Landscape Projects	50
Grade Separation (number)	3
Bridges (number)	15

NEVADA

The construction program of the state highway department for 1940 included 189 miles of low cost bituminous road work. Of the total 93 miles is classified as pavement widening. Other construction work completed involved 34 miles of stone and gravel (untreated) roadway, 4 bridges and 2 grade separations. Details of 1940 work and probable 1941 program are given in the tables.

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$2,487,279	\$2,230,000
Bridge Construction	33,907	35,000
Grade Separation Construction and Crossing Signals	200,000	152,000
Maintenance	763,075	875,000
Equipment Purchases	85,618	75,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)	Widened During 1940 (Mi.)	Uncompleted Carried Over to 1941 (Miles)
Bituminous Low Cost.....	189	93	78
Stone and Gravel (Untreated)	34	...	...
Bridges (number)	4	...	...
Grade Separation (number)	2	...	1

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)	Widening (Miles)
Bituminous Low Cost	47	95
Stone and Gravel (Untreated).....	47	...
Grade Separation (number) .....	...	1

PACIFIC STATES
WASHINGTON

In the funds tabulated below for expenditures in 1940 and probable expenditure for 1941, the accounts are divided into two groups. Highway construction includes road work, bridges, grade separations, right of way and location. Maintenance includes equipment purchases and rentals.

STATE HIGHWAY EXPENDITURES

	Expenditures in 1940	Estimated Expenditures in 1941
Highway Construction (including right of way and location)	\$ 7,500,000	\$ 7,000,000
Maintenance (including equipment purchased and rentals)	4,100,000	3,800,000
Total	\$11,600,000	\$10,800,000

MILEAGE OF STATE HIGHWAY CONSTRUCTION
COMPLETED DURING 1940

	Miles
Grading and Surfacing	163
Paving (high type)	8
Bituminous Surfaces	357
Bridges (number)	30
Grade Separations (number)	6

PROBABLE MILEAGE OF HIGHWAY CONSTRUCTION
IN 1941

	Miles
Grading and Surfacing	170
Paving (high type)	14
Bituminous Surfaces	650
Bridges (number)	20

The 1941 program is subject to legislative action which convenes in January, 1941, and therefore no schedule is available at this writing.

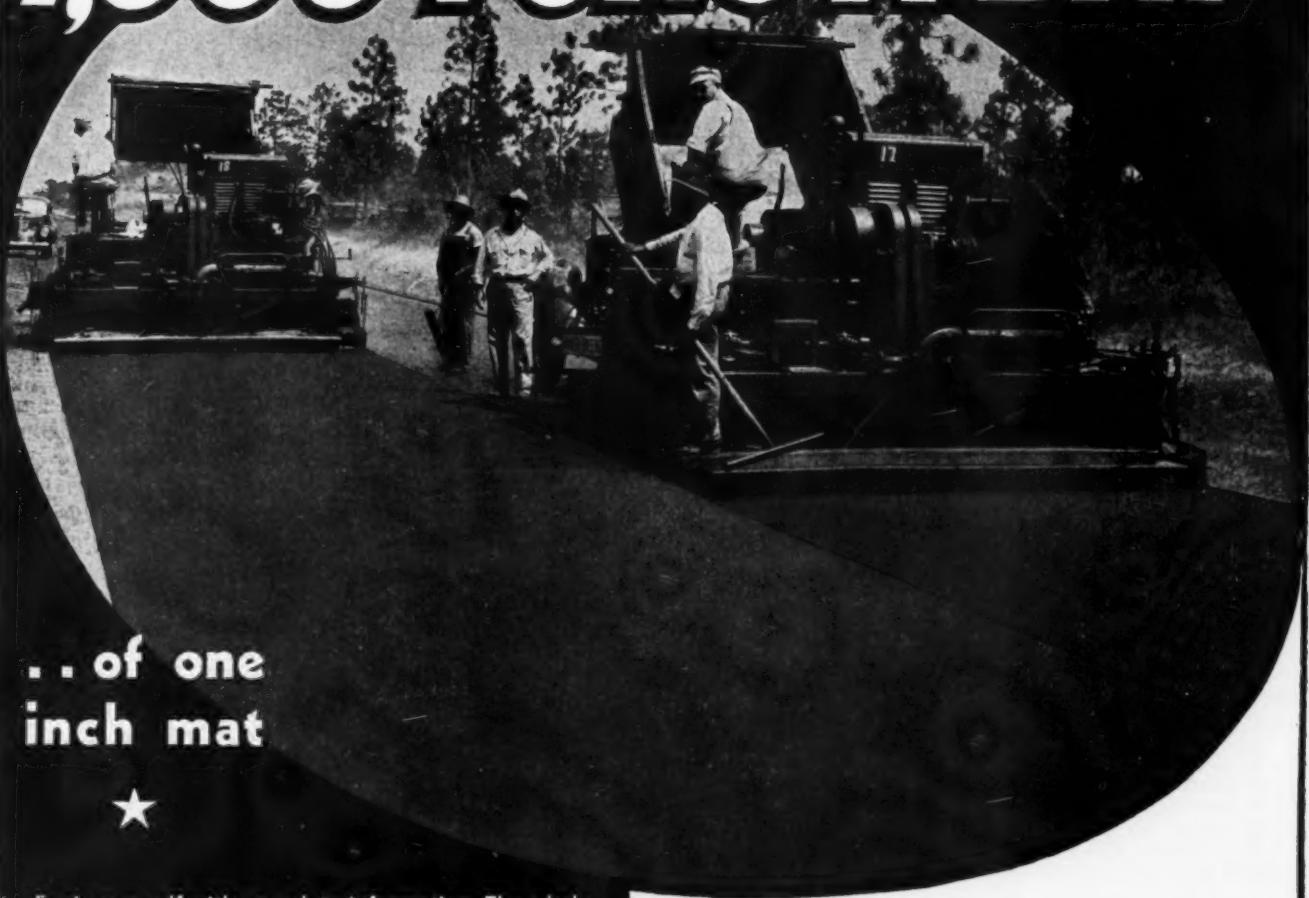
OREGON

The approximate expenditures by the state highway department in 1940 for highway construction, maintenance and equipment and estimated similar expenditure in 1941, together with mileages of construction work completed in 1940, and estimated mileage for 1941 are given below:

STATE HIGHWAY EXPENDITURES

	Approximate Expenditures in 1940	Probable Expenditures in 1941
Highway Construction	\$6,050,000	\$7,450,000
Bridge Construction	460,000	350,000
Grade Separation Construction.....	290,000	450,000
Maintenance	3,650,000	3,970,000
Equipment Purchases	425,000	350,000

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MILEAGE OF STATE HIGHWAY CONSTRUCTION

	Completed During 1940 (Miles)
Portland Cement Concrete	19
Brick	.....
Sheet Asphalt	.....
Bituminous Concrete	18
Bituminous Macadam	40
Bituminous Low Cost	394
Stone and Gravel (Untreated)	279
Stabilized Construction	.....
Grade and Drained Earth	165
Bridges (number)	36
Grade Separation (number)	5

PROBABLE MILEAGE OF STATE HIGHWAY CONSTRUCTION IN 1941

	Full Width Construction (Miles)
Portland Cement Concrete	15
Brick	.....
Sheet Asphalt	.....
Bituminous Concrete	20
Bituminous Macadam	40
Bituminous Low Cost	600
Stone and Gravel (Untreated)	450
Stabilized Construction	.....
Graded and Drained Earth	280
Bridges (number)	20
Grade Separation (number)	3

Uncompleted work which is to be carried into 1941 has been included in the totals of the probable mileage of state highway construction for 1941.

CALIFORNIA

Accomplishments of the California Division of Highways for 1940 may be gauged by the following brief tabulation of work placed under way during the past year.

Major Construction Contracts	\$16,449,600
Minor Improvements, Betterments and Day Labor	4,870,000
Assistance to City of Los Angeles for Improvements to State Routes with WPA and PWA Funds	1,822,000
Right of Way and Engineering	4,755,000
Total Jan. 1, 1940 to Dec. 31, 1940	\$27,896,600

Maintenance expenditures for the calendar year of 1940 amounted to \$10,586,300.

The \$16,449,600 allotted for contract construction provided for the following types of improvement.

Type	Miles
Grade and pave	46.8
Grade and plant-mixed surface	149.8
Grade and road-mixed surface	62.2
Grade and road-mixed surface treatment	111.6
Armor coat and seal coat	281.8
Grading only	39.3
Shoulder improvement only	17.3
Bridges and grade separations	(65)

During the past year the Division of Highways has awarded seven contracts involving stabilization of the subgrade by admixture of portland cement. The work performed under these contracts covered 34.8 miles of state highways and the projects were situated in Tehama, Merced, Santa Barbara and Riverside counties. The 34.8 miles are included in the paving and plant-mixed surface mileage given in the above tabulation.

The Division of Highways, as all state departments in California, operates upon fiscal periods covering two years and state highway budgets are prepared upon a biennial basis. At the present time the highway budget for the biennial period from July 1, 1941, to June 30, 1943 (93d-94th fiscal years) is in the process of preparation. As a large portion of the work for 1941 is to be financed from the funds for these two fiscal years, it is quite impossible at this time to give any detail of proposed construction and maintenance activities for the coming year.

Preliminary estimates, however, indicate that revenue from the following sources will accrue to the Division of Highways for the two years between July 1, 1941, and June 30, 1943.

Source	Amount
State's 1½-Cent Share and Cities' ½-Cent Share of the 3-Cent Gas Tax	\$73,000,000
State's ½ of Net Revenue from Motor Vehicle Fees	8,474,000
Use Fuel Tax (Diesel Oil, Butane, Etc.)	1,300,000
Regular Federal Aid Apportionments	7,600,000
Caravan Fees	226,000
Total Budgetary Revenue, 7-1-41 to 6-30-43	\$90,600,000

It is expected that this amount will be allotted to highway work in the following amounts.

¼-Cent Gas Tax to City Streets not on State Highway System	\$ 9,125,000
Maintenance	18,400,000
Shops, Equipment and Buildings	700,000
Highway Planning Survey	210,000
Construction and Improvement	57,940,000
Administration	3,900,000
Traffic Engineering and Investigation	325,000
Total	\$90,600,000

The sum of \$57,940,000 allotted to construction and improvement of the state highway system for the coming biennium will be allocated in approximately the following amounts:

¼-Cent Gas Tax to State Routes in Cities	\$ 9,125,000
Right of Way and Engineering	10,540,000
Joint Highway Districts	200,000
Construction Projects and Contingencies	38,075,000
Total	\$57,940,000

In addition to the above, it is anticipated that California will receive some \$1,480,000 in Federal Aid Grade Crossing funds and \$1,330,000 in Federal Aid Secondary or Feeder Funds.

A figure of considerable interest to the construction industry in the above breakdown of the proposed budgetary amounts is that of \$38,075,000 for construction projects and contingencies. It is from these funds that construction work and contracts will be performed.

With only this \$38,075,000 available for construction during the next two years, California is confronted with the proposed improvement of highways designated as of strategic importance in the program for National defense. Estimates of improvements to the highways in California included in the proposed strategic road system indicate that the necessary work to bring these roads to military standards will amount to about \$150,000,000. In addition, it is estimated that the cost of construction of access roads to cantonments, military and naval reservations will amount to \$11,000,000.

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TRACTOR CRUSHER UNITS	RC-2
ROCK FEEDERS	X-1
ONE PIECE OUTFITS	
SUPER TANDEM CRUSHING PLANTS	
STRAIGHT LINE CRUSHING PLANTS	G-1
TWO UNIT CRUSHING PLANTS	
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DRIVERS AND ACCESSORIES	AP-5
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PORTABLE STABILIZER PLANTS	STAB-1
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PORTABLE PLACER MACHINES	
DRAG SCRAPER TANKS	WP-1
SCREW WASHERS	X-1
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PLANT ACCESSORIES	X-1

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NATIONAL DEFENSE HIGHWAY FUND REQUIREMENTS

A Survey by ROADS AND STREETS Indicates Special Federal Authorization Will Be Needed

NATIONAL defense highway requirements are designated by three agencies who are clothed with this power—the Secretary of War, the Secretary of the Navy, and the National Defense Advisory Commission. The President requested Mr. John M. Carmody, Administrator of the Federal Works Agency, to prepare a report upon the adequacy of our highways for the national defense in collaboration with the War Department, the Navy Department, and the Advisory Commission. At the time this article was written, this report had not been submitted. It was expected at one time that it would be ready for the middle of October, 1940. This report will contain, we presume, the recommendations of the Public Roads Administration for certain definite defense highway requirements as nearly as can be ascertained at the time of the issuance of the report.

The data and information which follow have no connection whatever with this report. It is the results of a survey by ROADS AND STREETS of the requirements in highway work for national defense as understood by the states. The views expressed in this survey *do not* represent the views of either the Public Roads Administration or the War Department regarding necessary national defense highway work. They *do represent*, however, the views of the various states reporting and are submitted only as such. In this connection the reader should study the editorial in this issue.

ROADS AND STREETS undertook this survey for the purpose of determining how much money would be required, according to the opinions of the various states, for defense highway needs. Each state, naturally speaks only for itself in the light of the information it had at hand regarding defense highway requirements. Each state was asked for a statement, not exceeding 500 words, on funds that would be required for widening, for necessary by-passing of cities and towns, for strengthening of bridges, for access roads to camps and industrial areas, and for removing bottlenecks. A generalized summary of these reports indicates funds of the order of \$1,500,000,000 would be required. Following are the state reports:

Alabama

The state highway department authorities have received very little information concerning the strategic highways and military access roads for Alabama.

Our state highway department has furnished to the Public Roads Administration on their request much data relating to several of our primary routes. This, no doubt, has been considered by the Public Roads Administration and the War Department and Alabama is awaiting further action dependent upon a certain report of the Public Roads Administration on defense highway needs of the nation which is yet to be made public.

From the press and from reports of various organizations, it has been estimated that in Alabama there are some 1,200 miles of highways that may be considered

of strategic importance and that the cost to develop these highways to military standard would be some \$47,000,000.

Alabama authorities have no information from federal authorities as to the mileage of road that may be considered of military importance as access roads to cantonments, camps and other military facilities within the state. Other highways that are rural in nature that are the state highway department's responsibility yet to be improved to standard adequate for local traffic service is estimated at some \$34,000,000. Major bridges other than those on the so-called strategic system, it is estimated would cost about \$9,000,000. Grade separation projects should cost some \$10,000,000 and it is believed that at least \$30,000,000 would be required in the way of betterments to bring the Alabama state highway system up to an adequate standard for local traffic service within the next half decade.

Alabama has at this date several important centers of military concern which we know are in need of access facilities. The state highway department independently has made no study of these requirements.

With the above estimates that do not have to do with military access roads or roads of purely military nature, it can be readily noted that the Alabama State Highway Department or the State of Alabama with its present revenues could not afford to arrange to finance a program for immediate action.

We believe that roads constructed solely and exclusively for military purposes are essentially a national military preparedness item of expenditure and the cost of which should be borne by the federal government on the same basis as is the construction of cantonments, etc., and that it is unfair to ask the State of Alabama to participate in the construction of these non-highway projects.

For projects that will necessarily have to be over-built solely for the purpose of military use, it is our opinion that the state should participate in the construction of these only to the extent that finances will permit in the necessary work to care for present and future local traffic within a reasonable number of years. However, revenues at this date will not permit the participation in many of such projects in our state due to the fact that we already have heavy programs and agreements reached for the construction of rural state highways to state standards that will reasonably serve the present and future needs from the local state standpoint.

The Alabama Highway Department has no information relative to the increase of traffic on the strategic highway system or the access roads that might be caused by military action. However, we do have information relative to present and future needs for local use and truly to construct highways of a standard greater than that necessary for our road use with present revenues should not be permitted.



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It is believed that through national legislation an adequate basis of financing both roads of military importance and strategic importance can be made. These measures of defense are a national problem and should be financed nationally, assisted by the states through participating in the planning, programming and engineering activities necessary, which item of expense would necessarily be one of patriotic duty.

Arizona

In developing a cost estimate for strategic highway standardization on national defense roads in Arizona two selections, identified as Priority No. 1 and Priority No. 2, were considered. These two selections improved to the standards required by the U. S. Army in maintaining free movement of their equipment plus normal traffic would require considerable additional reconstruction not at present contemplated.

We have in the past made estimates of our receipts and expenditures and from these figures and forecasts have developed contemplated changes in existing roads and bridges. These estimates bear a fixed relation of obsolescence to revenue. It is a plan, scientifically constructed on facts, and will no doubt be carried out to completion as funds permit.

At this time when inadequate road service is being forcefully exposed the natural reaction is to eliminate substandard sections immediately to prevent the multiplication of danger to the defense plan. If such a plan were carried out all available highway funds would be concentrated on strategic highways in order to improve them to a satisfactory standard. With funds regimented in this manner the normal progress of improvement would become upset and the balance of the system sacrificed. This is unsatisfactory.

Realizing the importance of our main trunk highways to national defense should their use be required for this purpose, and having full knowledge of their substandard conditions in the event of a heavy military movement, it would seem logical to establish ways and means of financing such improvement without jeopardizing the normal improvement program of a state highway department. In this connection we have computed the cost of improving our strategic highways to an adequate standard, but we have not been able to determine from where the necessary funds will come to do the work without sacrifice to other important roads in the system.

What would appear to be a satisfactory solution, and at the same time maintain the planned continuity, would be to allocate funds to the whole system as originally proposed in the state's program, and the balance of funds necessary to expedite improvement of roads of great military value to be obtained from national defense appropriations. This plan provides the allocation of state and federal funds normally accruing to the various state highway departments plus federal funds required to meet the highway improvement needs of the War Department.

A brief tabulation of Priority No. 1 and No. 2 follows:

FIRST PRIORITY

FIRST PRIORITY							
	Total Miles	Miles Unsatisfactory	Total Cost				
	1149.0	988.8	\$12,910,500				
Major Revamp	Bridges Rebuild		Minor Revamp	Bridges Rebuild			
No.	Cost	No.	Cost	No.	Cost		
19	\$334,000	12	\$568,000	54	\$166,900	35	\$625,300

SECOND PRIORITY

The average annual expenditure by Arizona for administration, maintenance, equipment, betterment and construction is about \$7,000,000.

From the foregoing it is obvious that a special appropriation of federal funds is necessary.

California

The effect upon highway construction in California by the necessary readjustment in the financing of projects to meet the demands of the proposed defense system will be far reaching. The results of surveys made in this state for proposed improvements which would be required for the strategic road system indicate that approximately \$150,000,000 will be required in California. In addition to this amount, approximately \$11,000,000 will be necessary for construction of access roads to the several canyons, naval and military reservations planned for this state.

The appalling inadequacy of funds which will be available for highway improvement is clearly seen when these figures are compared with anticipated federal aid to be apportioned to California during the next two years and the total expected state revenue.

California's regular federal aid appropriations for the next biennial budget have been reduced 25 per cent which places an additional burden on this state in meeting defense demands.

From preliminary estimates of proposed apportionments to the state of federal aid funds it appears that California will receive during the fiscal years ending June 30, 1942 and '43 only about \$10,400,000 for regular federal aid, federal aid secondary and federal aid grade crossing funds. California must match the regular federal aid and secondary funds with some \$8,900,000 which will make a total of only \$19,300,000 for the first two years of the \$150,000,000 program for strategic roads in California.

It is most apparent, therefore, that the federal government must provide additional money for the strategic roads and for the access roads in greatly increased amounts if the program for national defense is to be accomplished.

Colorado

The improvement of national defense highways presents a very serious problem for Colorado.

This state, like other western states, has a large highway mileage and a relatively small population with the consequent result that highway income has not been sufficient to take care of the many demands for highway improvements. Today Colorado does not have sufficient state funds to match all federal aid available to the state.

In the face of these facts this new responsibility of improving national defense highways is a very serious problem indeed.

We estimate that a minimum of \$15,000,000 will be needed to improve approximately 1,200 miles of defense highways in the *rural* areas only.

This amount of money would take all of our state funds, matched with federal aid, for the next four to five years.

January, 1941

10-B AT WORK

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Obviously, we can't allocate all or a major portion of our funds for the national defense roads. Not only must we make needed improvements to provide for the traffic needs of our people, but we must also maintain the system now in use.

We are willing to co-operate to the limit of our resources with the national defense program. We are willing, for example, to appropriate state and federal aid funds for the improvement, to minimum standards, of those routes in the defense system which may be used by and be a benefit to the general public.

We are not in favor of spending our own state funds, together with federal aid, for the construction of four-lane highways on the defense system where this high type of road is not as yet needed by the general public.

As regards the construction of sections of road to serve military posts and camp areas we are firm in the opinion that these are purely of a military nature and should be constructed wholly out of funds provided by Congress for defense.

If time is an important element in the improvement of defense highways, then there is only one way to get the job done and that is for Congress to appropriate sufficient funds for the construction and improvement of those routes which are considered essential to the nation's defense.

Colorado and other states with a situation similar to ours can't take on the added burden of improving these defense roads out of regular highway income and at the same time satisfy the demands of the people who are paying their gas tax and other motor vehicle charges for the improvement of those highways which they use daily.

Connecticut

A total of over 500 miles of the 2,800 miles of Connecticut's state highway system is included in the first and second priorities for strategic highway standardization. These include roads with daily vehicle averages running as high as 45,000.

It is estimated by the Connecticut State Highway Department that over \$21,000,000 will be needed to provide the additional grading, drainage, resurfacing, shoulder construction, bridge and structure changes and right of way corrections.

The roads in the pattern serve to connect important coast defense areas and centers engaged in the production of large quantities of munitions, ordnance and other military material, in addition to serving the civilian needs of a densely populated area.

Grading and minor drainage corrections are required on 154.6 miles with 185.6 miles, including the foregoing, needing resurfacing. Despite the fact that practically all Connecticut state highways have stabilized shoulders a total of 199.4 miles need additional work to bring them to the standard set. Right-of-way changes are needed on 115 sections of road to permit the installation of standard features of construction.

Delaware

While the widening of roads and bridges on the strategic system of highways in Delaware amounts to approximately \$250,000 only, there is a bottleneck on U. S. 13 near the Pennsylvania line where the worst traffic situation in the state is now located. It will cost approximately \$1,000,000 to eliminate it. Another grade crossing not on the strategic system but leading immediately west from the City of Wilmington in which two railroads are involved and which would connect a divided highway with the street system of Wilmington would

require approximately \$400,000 or a total of \$1,600,000 for the state to adequately take care of this situation.

Florida

The problem of a study of national defense highway requirements is both timely and expedient. We have been vividly impressed with the necessity of rapid movement of supplies and troops in prosecution of modern warfare. Failure to incorporate necessary road improvements in our program of national defense could result in disaster.

Fortunately, the necessity for improvement of strategic roads has not been overlooked nor discounted. Yet, because of the very nature of road construction, it is necessary that agreements be made as to responsibility in order that improvements may not be delayed.

After the tentative selection of strategic military routes in this state, the Florida State Road Department made an estimate of cost necessary to bring these roads up to military standards. On the 2,117.8 miles of road, it was estimated that improvements costing \$68,094,400 should be made. In addition to the cost of improvements, it would be necessary to acquire additional rights-of-way, the cost of which is estimated at \$18,243,500, making the total cost of emergency requirements amount to \$86,337,900. The costs of improvements by items are as follows:

Needed Improvement	Mileage	Cost
Widening roadbed to minimum standard.....	1,767.500	\$14,491,400
Adding parking shoulders	18.950	85,100
Surfacing (widening, reconst. and new const.)	1,319.800	46,639,400
Major bridge structures—less than 85 ft....	2.034	2,147,400
Major bridge structures—over 85 ft.....	9.266	4,731,100
 Total cost exclusive of rights-of-way.....		\$68,094,400
Estimated costs of rights-of-way.....		18,243,500
 Total estimated costs of improvements.....		\$86,337,900

It should be pointed out that the above figures apply only to the cost of improvements needed on the system of strategic military routes and do not include the cost of constructing spur roads to military camps and naval bases. Since this state is strategically located for the operation of training camps and naval bases, the cost of constructing spur roads to the numerous reservations will be no small item.

Now, it is obvious that the people of this state cannot be expected to assume the financial responsibility of an improvement that is of national benefit and character. It is true that the people of Florida would benefit most from these improvements, and that the responsibility of maintaining an adequate road system is a function of the state. However, the standards required to facilitate military equipment are so much greater than the standards required to facilitate normal traffic that the cost of improvements are increased considerably. Federal appropriations should meet the entire cost of these extraordinary requirements. Furthermore, the estimated cost of the required improvements is many times the annual revenues available for road construction in this state. It is unconstitutional to borrow money for such purposes in Florida. So, it appears, that the only way this state can make the desired improvements in the desired time is by federal appropriations—appropriations in addition to the regular federal aid.

Georgia

In the state of Georgia, highways vital to national defense and of primary importance equal 963.32 miles;

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of secondary importance, 605.35 miles; making a total of 1,568.67 miles. The bridges on this selective system which do not meet War Department specifications amount to 121.

The state highway department's estimate of cost of this selective system for rebuilding, relocating, widening, et cetera, of highways and bridges amounts to \$45,350,-800.00. Information as to how this mileage and cost were arrived at is given below:

1. Mileage of roads under supervision of state highway department which have been designated as of special importance to national defense.	
(a) Of primary importance, miles.....	963.32
(b) Of secondary importance, miles.....	605.35
Total miles	1,568.67
2. Bridges on this selected system which do not meet War Department specifications (number).....	121
3. State highway department's estimate of mileage on this selective system as of immediate concern for improvement:	
Primary:	
Rebuilding, relocating, or widening, miles.....	831.06
Estimated cost	\$22,776,500
Secondary:	
Rebuilding, relocating, or widening, miles.....	572.45
Estimated cost	\$17,434,300
4. Bridges	
Primary System:	
(a) New (number)	69
Estimated cost	\$2,970,000
(b) Widened and/or strengthened (number)....	17
Estimated cost	\$210,000
Secondary System:	
(a) New (number)	35
Estimated cost	\$1,960,000
(b) Widened and/or strengthened (number)....	0
Estimated cost	0

Idaho

Strategic highway standardization in Idaho will apply to 683 miles of first priority roads estimated to cost \$9,413,700, and 503.6 miles of second priority roads estimated at \$11,772,400, plus \$3,340,000 for first priority by-passes, a grand total of \$24,526,100. Included in the above is \$4,035,300 for first priority parking shoulders and \$3,295,200 for second priority parking shoulders.

Idaho normally places 45 per cent of its regular federal aid and grade separation funds on the 1,186.6 miles of the strategic system, being \$1,057,050 per year or \$5,285,-250 for a five-year period. On this basis Idaho would provide \$5,285,250 for either first or second priority roads or both.

First priority	\$ 9,413,700
By-passes	3,340,000
Total	\$12,753,700
Provided by state	5,285,250
Government, first priority.....	7,468,450
Government, second priority	11,772,400
Government, first and second priority.....	\$19,240,850

Bridge costs have been included in the above. Idaho meets military requirements as the legal gross loads are 68,000 pounds and axle loads 18,000 pounds. The length of a single vehicle is 35 feet, and full truck and trailer 65 feet.

The Idaho estimate of cost of the strategic highway standardization of 1,186.6 miles has been based on minimum requirements.

The determination of the dividing line between improvement in place and relocation is admittedly difficult in this western country where the prospect of additional funds brings within range so many possibilities of ex-

tensive revisions. However, the objective of time, and the dual service to be provided, draws the improvements back closer to the existing location and permits only minor revisions. Simplicity, strength, and time saving must supersede the luxury of the bolder outline, which can be carried out after purely military purposes have been accomplished. Highways disrupted by reconstruction in the midst of military use would be fatal to the purpose of the improvement. Time for building the extensive detours would not even be available.

It would seem that the projects that do not permit ready detouring should be placed very high in the program and so be completed before the climax is reached while those permitting easy detours or alternate routes be placed low in the program.

The intermountain area, of which Idaho is a part, lies between the main sources of military supply and between the areas of expected military operations. This area is one requiring dead haul between centers of operation. It is an area of great distances, sparse population, and arid lands. For the purpose of military highways, however, these liabilities become assets, because this area affords the possibility of the longest stretches of sustained high speed travel of any of the highway routes to the Columbia River and Puget Sound, if undertaken in a large way.

In northern Idaho, improvement encounters extreme difficulties in heavy mountain rock work on U. S. 10 and U. S. 95 along rivers and lakes closely confined by mountains and where U. S. 95 leads north to Canada.

It will be found that the limitations of the mountain and arid states as to roads involve many strategic control points which in time of emergency will affect the movement of traffic hundreds of miles away from them. The essential of programming would seem to be the avoidance of aggravating this situation by neglecting to provide adequately for the detour situation which will affect the dispatch and success of the entire undertaking. The East has a multitude of road alternatives from which to select, while the intermountain country is controlled by a few canyons and divides.

Illinois

The War Department has designated 1,977 miles of the Illinois primary system as highways strategically important to the national defense. All of these roads are now paved. However, many of them were improved a number of years ago, and fall far short of the standards their strategic importance justifies. A survey of this strategic network has been made, and it was found that only 510 miles meet minimum requirements. On 920 miles the needed improvements consist only of shoulder widening, but this work alone is estimated to cost \$6,300,-000. Reconstruction of existing pavement, including considerable mileage of relocations, is required on 131 miles, and is estimated to cost \$20,500,000. In addition, the need for 144 miles of new routes at a cost of \$30,700,000 is indicated. The total estimated cost to modernize the defense highway system is, therefore, \$57,500,000.

In addition, a survey has been made of the highway improvements needed to provide proper access to the several military camps and reservations in the state. The total estimated cost of these improvements is \$15,000,000. Therefore, the total defense highway bill in Illinois, according to estimate, is \$72,500,000. If the state were to devote all of its available construction funds, including federal aid allotments on the present basis, to these defense roads, five years would be required to finance the job.

It is, of course, not possible for the state to assign its construction funds exclusively to defense work. It is

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admitted that all of the roads in the strategic system are also important from the standpoint of purely civilian usage. However, there are many miles of highways in the state not on the designated system which are urgently in need of reconstruction and modernization, and which are highly important from the standpoint of peace-time use. If construction of the latter roads would be deferred in order to concentrate construction funds on the strategic system, a very large percentage of our highway users would have to be content with inadequate service, and maintenance expense on many miles of road would jump to an excessive figure. While there is an obligation on the part of the state to give preferred attention to the modernization of the defense system, it cannot abandon consideration of the rest of its primary roads.

The federal government and the state have agreed that about \$4,000,000 would be a fair amount for Illinois to spend on defense highway projects during 1941. This is more than 70 per cent of the state's combined federal aid allotments for this year. Such an expenditure will take care of only about 5½ per cent of the needed improvements. It is apparent that at the rate of \$4,000,000 per year progress towards an ultimate goal of \$72,500,000 is going to be very slow. It is further apparent that the state can hardly hope to be able to step up, appreciably, this rate of progress.

This, I believe, is the situation in all of the states. If modern highways are as vital to national defense as we believe they are, the cost of building them should be considered as a defense expense and federal funds should be provided for building them. Surely, the fact that these facilities will render valuable peace-time service for many years after we hope the present emergency shall have passed, should in no way detract from our estimate of their military worth. If a million dollar highway improvement is essential to defense, it is entirely proper to pay for that improvement with defense funds. The fact that such improvement would have subsequent civilian utility should be considered a virtue—a virtue which very few other types of defense projects would have.

Indiana

A rough estimate of the cost of the several road and bridge projects under construction or considered necessary as part of the national defense program follows:

Estimate of mileage on primary system needing improvement to War Department announced standards is 185 miles of rebuilding, relocating, or widening at an estimated cost of \$803,400. On the secondary system there are 90 miles of this type of work estimated to cost about \$515,400. Three new bridges will be required at a cost of \$143,000.

Aside from those highways shown on the defense system, there are other roads on the state system important for the national defense. These roads lead into airport development, ammunition depot, ordnance plant, powder plant, and military post. Involved in this category of construction are 61.7 miles which will cost approximately \$2,497,000, the expenditure of which was not contemplated by the state highway commission when the 1941 and 1942 program was planned. Of course, full details are not available so these figures are estimates only.

Kansas

As a very rough estimate, with reference to defense highway needs and with particular reference to funds, we might say that excluding access roads for which we have little information, other apparent strategic routes will require approximately \$32,000,000. The grading

and drainage would involve an expenditure of approximately \$7,500,000; surfacing, \$19,250,000; structures, \$5,250,000. In addition to these construction costs right-of-way would probably cost in the neighborhood of another \$1,250,000.

Kentucky

In Kentucky so far the War Department has indicated that 715.6 miles of our highways are of primary importance, and 306.7 miles are of secondary importance, or a total of 1,022.3 miles.

On this mileage we have at present 57 bridges which do not meet War Department specifications. On this selected mileage there will be required 153.2 miles of rebuilding and relocating, at an estimated cost of \$5,025,500. On the roads of second priority there will be required 47.2 miles of rebuilding and relocating, at an estimated cost of \$194,300.00.

Of the bridges mentioned above, we will need to rebuild entirely 37, at an estimated cost of \$3,227,000.00, and widen or strengthen 19 bridges, at an estimated cost of \$250,000.00.

On access roads we have agreed to build one four-mile section which will cost in the neighborhood of \$85,000.00. We have agreed to furnish the necessary engineering, surveys and plans, and supervise the construction for the access and tactical roads needed at Fort Knox.

In addition to the sums mentioned above, we estimate that it will require in the neighborhood of \$3,000,000.00 for these access and tactical roads around Fort Knox, none of which we have agreed to furnish.

It is our sincere belief that, when we designate any available federal aid allotments to work on these strategic highways, we have done all that could be expected, and we believe that the balance of the funds should be set up as part of the necessities for national defense, with a separate appropriation therefor.

Louisiana

Strategic highways in Louisiana on which cost estimates were prepared to bring them to a standard as set by the War Department were classed as first, second, and third priority.

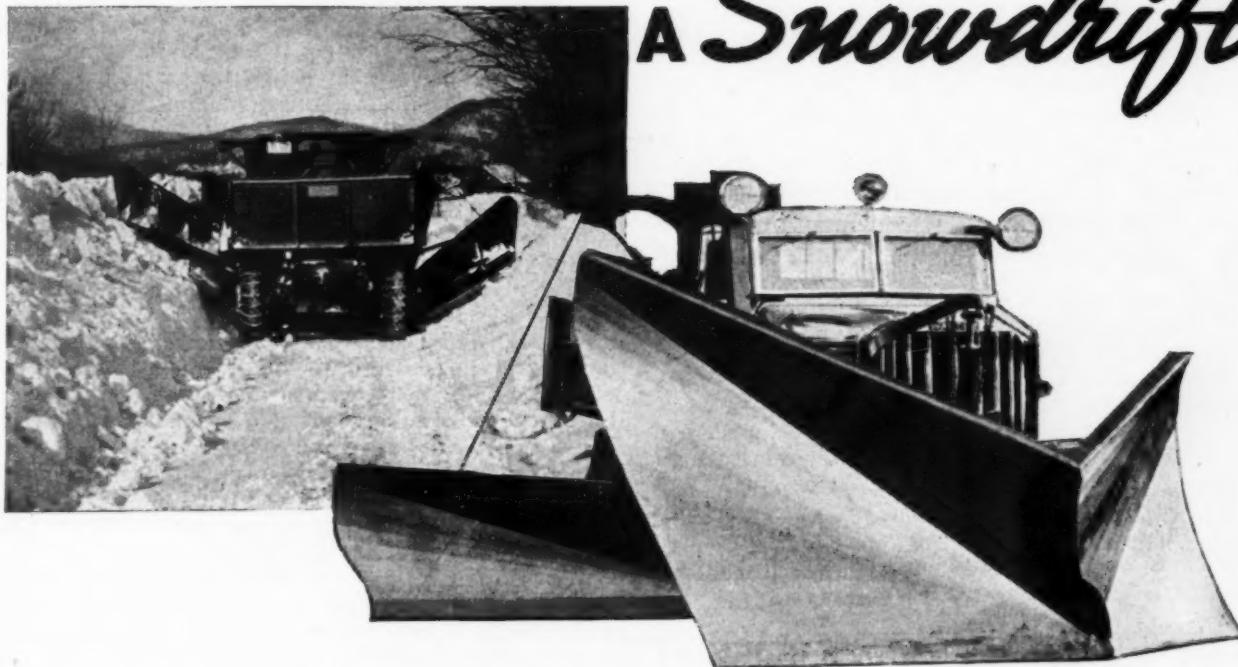
A summation of these priority routes is as follows:

Mileage Designated	Miles
First priority	584.2
Second priority	695.4
Third priority	22.4
Total miles involved	1,302.0

	Miles	Cost
Reconstruct first priority	467.7	\$11,599,200
Reconstruct second priority	618.1	14,241,900
Reconstruct third priority	20.7	605,700
Total	1,106.5	\$26,446,800

Bridges	Number	Estimated Cost
First priority—new	98	\$2,553,900
First priority—rebuilt	6	17,600
Second priority—new	46	3,272,500
Second priority—rebuilt	1	50,000
Third priority—new	2	14,700
Third priority—rebuilt	0	—
Total—new	146	\$5,841,100
Total—rebuilt	7	67,600
Totals	153	\$5,908,700

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The total estimated cost of all work to raise to the required War Department standard was \$32,355,500.

Maine

It is very difficult to give any more than a very rough estimate of the cost of reconstruction of highways to make them more adequate for military roads. We know, of course, that many of our highways are not adequate and that such reconstruction is necessary but any estimate at this time must be necessarily based on our knowledge of conditions and our judgment rather than on the results of actual surveys.

Under these conditions, we have estimated that it would require a minimum of \$30,000,000.00 to do the reconstruction which we believe should be done to better serve military needs. This has taken into consideration the widening of shoulders and the reconstruction of some of the bridges where such reconstruction is most needed. Many of our important highways have only narrow shoulders, 3 ft. to 4 ft. in width, and widening to minimum requirements we estimate would cost around \$13,000,000 or \$14,000,000. Our estimated cost of replacing structures absolutely required is around \$3,500,000 and the balance of the cost, of course, is on other items of needed improvement.

At the present time this department has no funds particularly set up providing for the construction of highways and bridges from a military or defense standpoint. We shall, of course, try to cooperate in every way possible for the expenditure of such funds as we may have on locations where they will serve military needs.

Maryland

During the summer of 1940 we received the recommendations of the War Department setting forth highways within Maryland to be included in the first, second, and third priorities of the so-called strategic net. Tentative plans and cost estimates were made covering a construction program that would bring these highways up to minimum requirements as to widths, shoulder construction, and load carrying capacity (9,000 lb. wheel load). Whatever bridge strengthening or replacement might be necessary was included. The first priority embraced 194 miles; the second priority, 300 miles; and the third, 134 miles, or a total of 628 miles.

After a careful study of the problem, it was apparent to us that to bring the existing highways up to the standard of minimum requirements would require the acquisition of additional right-of-way area, at an estimated cost of approximately \$11,000,000, and would, in many instances, require the continuation of bad alignment, grades, and locations, and would further cause considerable interruption to traffic over an extensive mileage during the reconstruction of the routes named. Our estimate of the cost of bringing these highways up to the standard of minimum requirements fixed, amounts to \$48,700,000, including cost of rights-of-way as named above.

After a careful study of the problem, it seemed advisable to us to suggest extensive relocation of a number of the roads and the suggested addition of certain mileages not included in the original program presented to us.

Our recommendations embraced 204 miles in the first priority, 317 miles in the second, and 132 miles in the third priority, or a distance of 653 miles, at an estimated cost of \$66,300,000, including right-of-way costs, amounting to \$13,600,000.

Practically all of the construction work on the pro-

gram suggested by us could be carried on without interruption to traffic as traffic could use existing highways during the construction of the new mileages. All of the work recommended as an alternate to the suggested program would be of definite permanent value to the state highway system of Maryland, as well as providing an immediate solution in the present military emergency.

This state, under present financial arrangements, has only from six to seven million dollars annually, including regular federal aid allocations for the construction of highways. Because of the limitation of funds annually available, it would be impossible for us to complete the program of construction on the strategic net within any reasonable period of time to make it effective to meet the emergency condition which the military situation has created.

We, therefore, urge that immediate consideration be given to special federal appropriation to cover the work required in order that it be effectively completed within a reasonable period of time.

In addition to the strategic net and the work that would appear to be necessary to properly improve it, we have prepared a program of access roads to the various military reservations within the state, which include Edgewood Arsenal, Aberdeen Proving Ground, Camp Holabird, Fort George G. Meade, and the Indian Head Proving Ground. We also have given consideration to the Dahlgren Proving Ground, which, although located in Virginia, requires travel across the state of Maryland from Washington by way of our new Potomac River bridge in the vicinity of Dahlgren.

We also felt it proper to include the Glenn L. Martin Company's airplant plant located in Baltimore County. This plant is of vital importance to any military program in the quantity production of military aircraft. The plant is so situated between our New Philadelphia Road and the Chesapeake Bay as to create an extremely acute highway transportation problem and the solution of which is of primary importance.

The estimated cost of constructing all of these access roads to satisfactory standard of width, strength, and location, including certain grade-crossing eliminations over railroads, as well as over certain important highways, is approximately \$13,000,000.

If we were to undertake the financing from state and federal aid funds of this construction program, it would mean the complete elimination for approximately two years of all work on our main system of highways, which, of course, would also eliminate the possibility of any work on the strategic net as described in the early part of this letter. Furthermore, most of these access roads would be of little importance to the state highway system after the conclusion of the present military emergency.

We, therefore, are in the position of having no funds whatsoever for this work and are urging that special federal appropriation be provided to cover the cost of these access roads.

We are fully cognizant of the seriousness of the problem presented and are anxious and willing to do our bit to the fullest extent possible to provide the solution, but we feel that it would be impossible for us to provide any satisfactory results were we forced to depend on our own very limited financial resources.

It must be apparent to anyone that for a small state with a population of only 1,600,000, we are, because of our proximity to the national capital, because of the large important military establishments within our border, and because of the fact that our state contains at least one route of great national importance, namely, the highway



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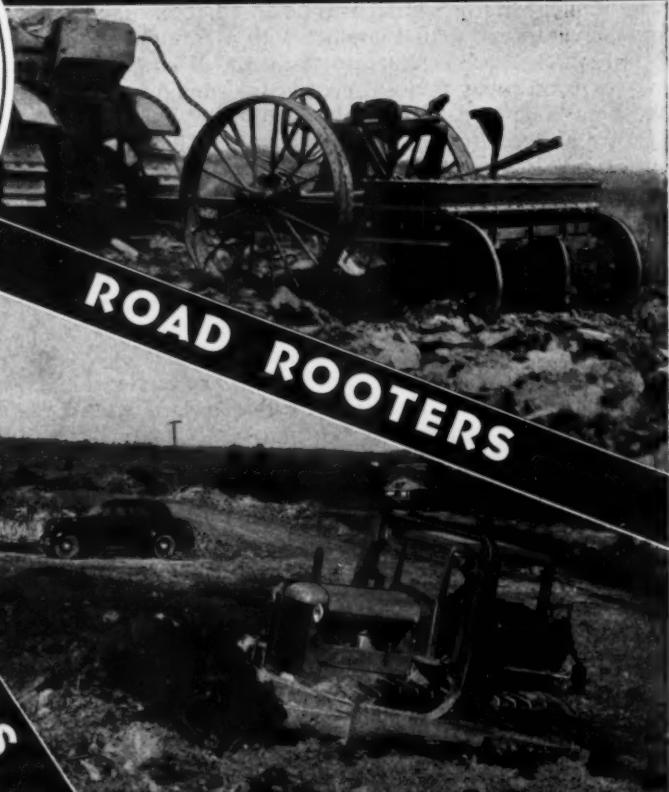
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Massachusetts

Defense highway fund requirements for Massachusetts may be summarized as follows:

Out of 337.5 miles of first priority roads in the state, 90.7 miles need rebuilding, relocating or widening at an approximate cost of \$5,057,000. Second and third priority road mileage totals 685.5 miles of which 409.5 miles will need reconstruction of some kind to conform with defense requirements. The estimated cost of reconstruction of this second group is \$29,931,000.

With respect to bridge work, on the first priority road net, two new bridges should be erected at an approximate cost of \$90,000. On the second group of roads four new bridges estimated to cost \$1,506,000 should be built and five should be widened at an estimated cost of \$50,000.

In addition to the above, certain access roads are needed to reach army camps, forts, airports, and shipyards. The department estimates the cost of constructing these to be \$7,000,000.

Total funds estimated as required for national defense highway work in Massachusetts would be \$43,634,000.

Michigan

Michigan, like other states of the nation, stands ready to do its full share in our national defense effort. Factories here are being called upon to provide much of the material for our actual armament and industrial defense.

Highways must carry much of the material and many of the finished products of these great industrial plants. In addition, the highway system must be ready to meet the demands of the army in its movement of troops and the implements of actual warfare—whether in practice maneuvers or in actual combat with a foreign enemy.

In spite of consistent improvement, Michigan's highway system today is not prepared for such a load. Highway authorities realize this and are now looking to the future in order to better meet the responsibilities that lie immediately ahead.

Michigan has within its state trunkline system 2,400 miles of highway designated by the War Department as being of strategic military importance. An analysis of these roads reveals that \$15,000,000 will be required to meet immediate actual minimum requirements.

These recommendations do not include proposed expenditures for highways to airports designated as important to national defense, industrial production plants, and tactical roads. Facilities of this nature would require an estimated \$8,500,000.

Even with this program completed, highways would not be adequate for efficient service. Rather these improvements would merely bring traffic to state trunkline highways which are already overloaded. By-pass routes and other extensive construction would be necessary to meet this third phase of a complete national defense highway program to meet immediate requirements. It would involve a total expenditure of probably \$34,000,000.

In other words, Michigan's immediate needs would require a total of \$57,500,000. Present normal programs of the department will provide but a mere fraction of that amount. Highway engineers and administrators are ready and anxious to meet the challenge of national defense. Just as in other phases of the defense program, however, special funds must be made available if they are to meet this very special and very vital challenge.

Michigan already has launched and carried forward the first strictly military highway construction project in the nation. A four-lane highway is being constructed at Fort Custer through the encampment there. Its total cost will be in the neighborhood of \$1,000,000. This money is coming now from normal federal aid sources and its use for this project has forced the cancellation of other needed projects on state roads.

First things must come first. Michigan will cooperate to the limit of its ability. But the job is bigger than any present source of revenue that can possibly be tapped.

Minnesota

Some time last fall we received a description of the general location of highways which were considered as being of strategic military value in the state of Minnesota. At the same time we were requested to prepare an estimate to bring this mileage up to the minimum standards.

In compliance with this request we made an office survey of the roads affected, together with an estimate of cost of the work which would be required to bring this up to at least the minimum standards. In some cases our estimate is based upon a type of road which exceeds the minimum standards on account of the fact that this road would carry heavy amounts of civilian traffic in addition to that imposed directly by military requirements.

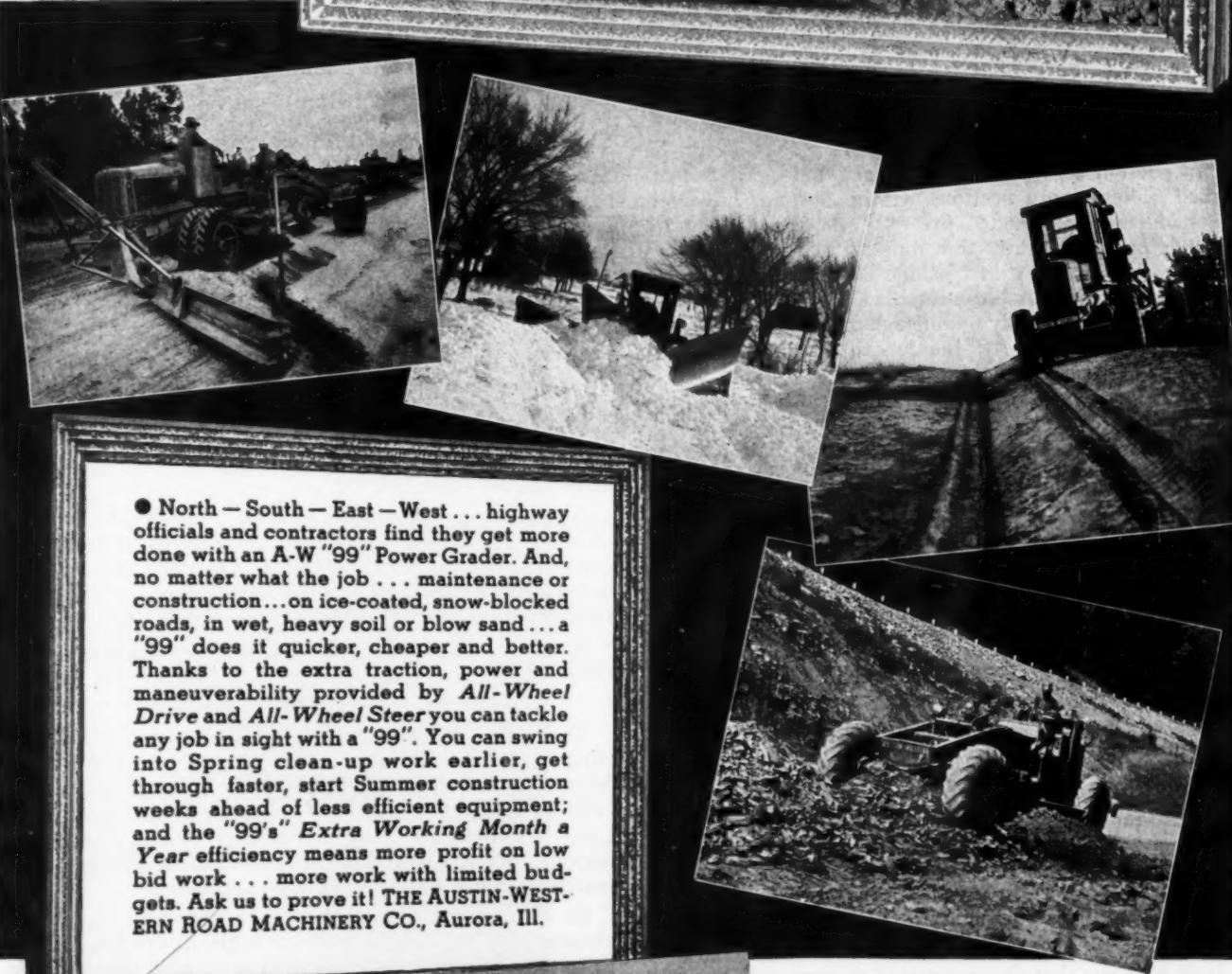
We have made our estimates of cost in accordance with three priorities. We originally estimated a first priority system and then after further study estimated an alternate schedule for the first priority, with the feeling that traffic would be better accommodated by the routes chosen after more thorough study. The original first priority consisted of 952.5 miles and the total estimated cost was \$12,201,000. The alternate selected for the first priority, while it embraced in a general way the routes considered in the first estimate, omitted some of the first routes and substituted others in their place. On this account the mileage was slightly shortened but the total cost was increased. The alternate routes for the first priority embraced 938.2 miles and the total estimated cost was \$14,699,000. While the cost is slightly greater we felt that much better service would be given to both military and civilian traffic by the selection of these routes as compared to those considered in the original estimate.

The second priority was composed of 512.1 miles with an estimated cost of \$7,117,700 while the third priority consisted of 308.1 miles at an estimated cost of \$4,487,700. The total cost for the three priorities, using the alternate routes for the first priority, is \$26,304,400.

If we should be obliged to immediately move in and improve all of these roads it would take all of the federal funds, together with all state funds available for matching, to take care of this requirement, and even then it would require several years to insure completion of all these routes. This would mean that all other road construction within the state would be neglected during that period, which would probably have a disastrous effect upon highway administration within the state.

We are willing to take care of the work on the strategic net-work in the order in which we would plan it if it were not included in this net-work, but if extraordinary requirements are made, either in the type of construction or in the speed of construction, we feel that we should receive additional aid from a federal source. Our present trunk highway system comprises 11,000 miles and it can be seen that if we were to concentrate all of our funds on approximately 1,700 miles

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during the next several years that parts of the state not benefited would be extremely critical of any such procedure. In many cases some of the roads included in this are reasonably adequate for the traffic they now carry and the increased expenditure would be primarily for the benefit of military traffic.

It is our belief that with the tremendous sums which are being expended for military preparation that some substantial part could well be devoted to improving highways which are believed to be of military value.

Mississippi

Last fall this department was advised that certain routes in Mississippi had been designated as strategic highways. We then made a study to determine the estimated cost of the work necessary to improve these routes in order that they meet the required minimum standards adequate to service military traffic. The amount decided upon to finance this work approximates \$14,133,900, which, in comparison with the estimates of other states, is rather low. In explanation of this fact, we wish to state that we are just completing a four year program of highway construction that has involved the expenditure of approximately \$90,000,000. Naturally, therefore, the mileage in this state that needed improvement to place same in the category where it would meet the minimum standards was low.

Mississippi has a state maintained system of approximately 6,500 miles, and over fifty per cent of this mileage has been hard surfaced. In the last four years the major portion of this hard surfacing has been accomplished. There were sections of the system, however, that had been constructed prior to our recent program and it is on these routes that most of the work such as relocations, rebuilding and bridge construction included in the estimate occurs. Along with these inadequate sections we have practically no mileage on our system where the shoulder widths for the length required met the requirements necessary to service military traffic.

At this time we have no definite program for this kind of work or for access road work.

We estimate that 847.1 miles of road in this state are first priority roads as designated by the War Department. Second and third priority route mileage amounts to 119.5 miles. Out of the first group 266.1 miles should be rebuilt, relocated, or widened at an estimated cost of \$7,847,900. In the second group are 36.0 miles of road needing similar work to bring them to the minimum standards. The cost for this group is estimated at \$1,356,000.

On the first priority roads 38 new bridges estimated to cost \$4,470,000 would be needed, while on the second group, four new bridges estimated to cost \$460,000 would be required.

Missouri

Approximately 2,000 miles of Missouri's 15,800-mile state highway system have been designated as strategically important to the national defense.

The 1,142 miles classified in the first priority group coincide generally with heavy traffic arteries that are also particularly important for ordinary traffic service.

It so happens that this important mileage was the first constructed in the state, and, because of accelerated deterioration and the more or less obsolete standards of design and construction used in the early days of road building, is in need of serious improvement and reconstruction.

It is the intention of the state highway commission to concentrate funds on this first priority group of high-

ways insofar as possible. However, it must be pointed out that the demands for improvement of the remaining 14,658 miles in the state highway system are urgent and that funds for all highway purposes are extremely limited at this time.

Consideration of the mileage in the second and third priority groups leads to the conclusion that in general this less important mileage is satisfactory for ordinary usage.

Development of higher standards than are demanded by peace-time activities is a bill that should definitely be charged to the cost of defense rather than to ordinary road users funds.

Road leaders in Missouri have always believed that funds appropriated by the Congress to the various states for road building purposes are derived from the individual states and that annual allocations are the result of a wise federal control of distribution, rather than a gift to local governments. It is realized, of course, that the national defense is important to every state in the nation, and it is the desire of the Missouri State Highway Commission to cooperate in the defense plan to the fullest extent of its ability. However, ordinary traffic service must not suffer by reason of these particular expenditures. It does not seem illogical to assume that defense highway development over and above ordinary requirements should be financed in a manner similar to other defense projects.

Following is an estimate of cost prepared to show the amount of funds necessary to prepare Missouri's roads to conform with desirable national defense minimum standards:

First priority	1141.6 mi.
Second and third priorities	776.2 mi.
Total	1917.8 mi.

Number of bridges on these roads which do not meet specifications, 80.

Of immediate concern on the roads of first importance for improvement are 603.4* mi. estimated to cost \$18,200,400. For rebuilding, relocating or widening those roads of secondary importance 646.1** mi. are estimated to cost \$24,140,300.

As for bridges, one new \$100,000 bridge will be needed on the first group of roads and 20 widened or strengthened at a cost of about \$311,100. On the roads of secondary importance, 59 bridges would need widening or strengthening at an estimated cost of \$974,400.

None of these figures include estimates for access roads.

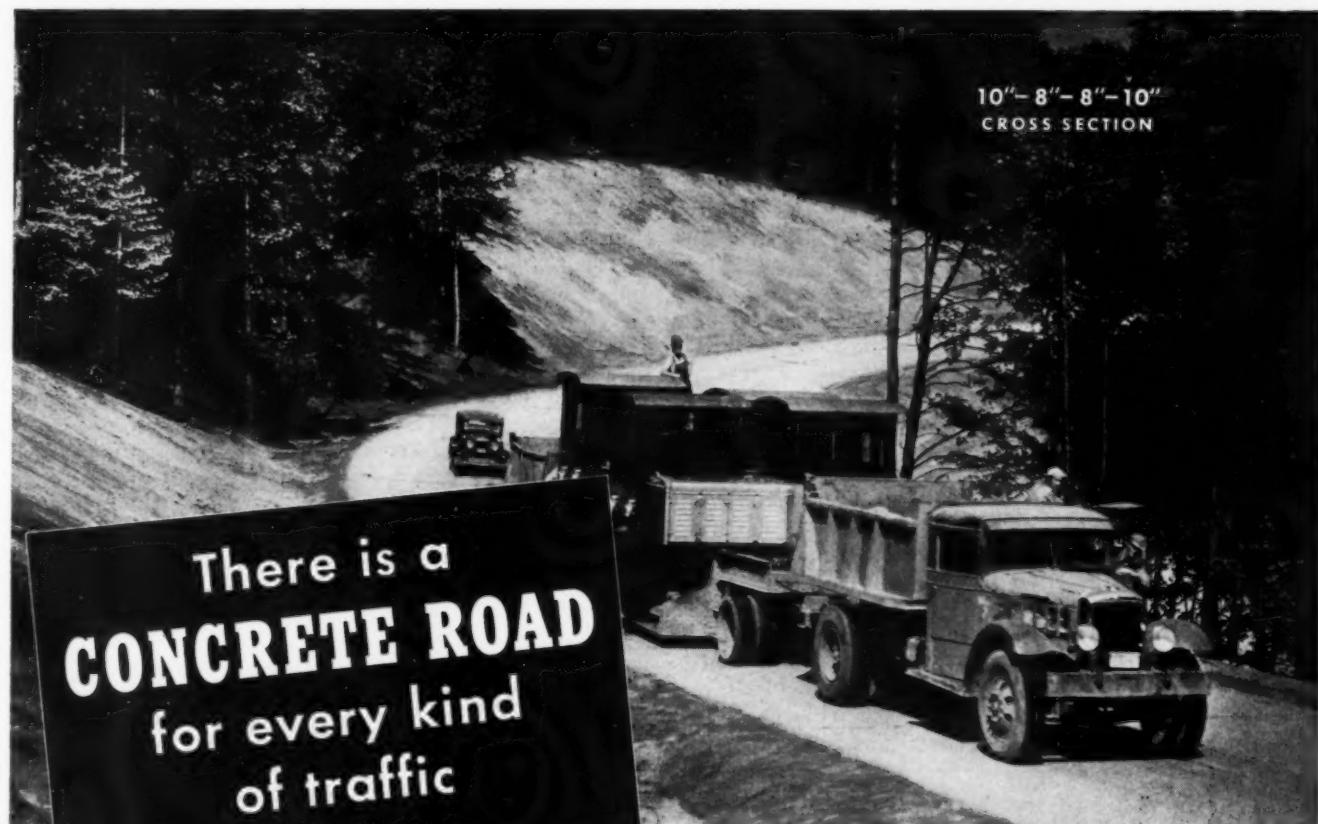
Nebraska

The situation existing in Nebraska now and which has existed for several years is one wherein the amount of Nebraska state highway construction funds is insufficient to match all the federal aid made available by Congress. Consequently, any increase of federal funds for national defense would be of no particular advantage if matching with state funds was necessary.

In connection with proposed construction or reconstruction of Nebraska's strategic highways to bring them to minimum standards, I am of the opinion that in view of the fact that funds now available, both state and federal for Nebraska, are not sufficient to take care of

*Includes 527.4 mi. of widening and stabilizing shoulders. In addition there are 380.2 mi. on which parking shoulders only should be provided.

**Includes 390.5 mi. of widening and stabilizing shoulders. In addition there are 110.3 mi. on which parking shoulders only should be provided.



Above: Route 71 (Norris Freeway) in Anderson County, Tenn. Built heavy to carry thousands of massive trucks and machinery trailers during construction of Norris Dam.

Left: Tennessee Route 15, Lincoln County; Route 15, Franklin County; Route 18, Madison County.

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our immediate ordinary needs, any additional work of a major nature that is needed for designated national defense roads now sufficiently improved for normal use, should be financed by special appropriations for national defense and without state matching. Obviously, if the inadequate funds now available for normal use have to be used to further improve strategic highways for national defense purposes, this will mean a concentration of highway expenditures for improvements not needed at this time for normal traffic and will delay, or as a matter of fact, practically eliminate normal necessary improvements on Nebraska highways which have not yet been improved to a satisfactory standard and which are needed at this time for normal peace time pursuits.

I believe that the policy of the American Association of State Highway Officials who went on record at the Seattle convention last September, recommending that the federal government provide and make available separate and sufficient funds for national defense roads is sound. I also believe that any such expenditures on state-federal highways should be through the regularly established channels cooperating with the defense agency involved, such as the Army or Navy.

An estimate of the extra funds needed for Nebraska for widening, by-passing cities and towns, strengthening bridges, and constructing new sections of roads or streets in industrial areas, camp sites, etc., totals \$14,215,000.

A summary of the estimated costs is as follows:

Primary importance	
463 miles rural	\$7,130,000
45 miles urban.....	1,950,000
Subtotal	<u>\$9,080,000</u>
Secondary importance	
283 miles rural	\$3,800,000
20 miles urban.....	135,000
Subtotal	<u>\$3,935,000</u>
Not designated by War Dept., but considered as of defense importance	<u>\$1,200,000</u>
Estimated Total	<u>\$14,215,000</u>

The above estimate has been made on the basis of information available at the present time and is subject to revision as new information is made available and as new needs develop.

Nevada

Nevada will need a minimum estimated sum of \$11,807,800 to bring its highways of first, second and third priorities up to the standard required for the strategic network of war defense highways, but unless special defense funds are made available for this work it will require at least five years to bring the first priority selected highways alone up to the standard. This statement is based upon the premise that the proportionate amount of federal aid funds, as allocated for the years 1942 and 1943 would be continued during succeeding years. If special war defense funds, in addition to regular federal aid, are assigned to the state highway construction of course could be greatly facilitated in bringing the network up to the required standard in much less time.

This war department strategic network, including all priorities, embraces highways having a total mileage of 1,469.3 of which 667.4 miles will need improvement to conform with the design requirements set up by the department.

There are 5,203.41 miles of road in the established Nevada state highway system, of which 2,915.62 miles

have been improved to this time. Under normal conditions the remainder of this system could be completed to the accepted higher standard in the course of probably twenty or thirty years. Because of the few rivers of any size in the state and the excellent condition of the present bridge structures only 34 units will be affected by the strategic network defense plans, and these could be brought up to the required standard at a minimum estimated cost of \$650,000 which would include the widening of old structures and the building of new ones. The strategic network of war defense highways involves seven Nevada highway routes, including four east-west routes and three north-south arterials, embracing all priorities.

In the highways comprising the first priority for construction and bringing up to the war defense standard, there are 657.7 miles of which 318.3 require improvements at a minimum estimated cost of \$6,159,100 while those embraced in the second priority category contain a mileage of 693.4 of which 232.7 require improvements at a minimum estimated cost of \$3,619,900, and those of the third priority involve a mileage of 118.2 of which 116.4 miles need improvements estimated at \$2,028,800.

Nevada is prepared to finance its share required to meet federal appropriations. At present federal aid funds are made available to the state for construction only, in the amount of 87 percent of the cost, while the state's share of construction only consists of 13 percent. As the state is required to finance all costs of surveys, preparation of plans and rights of way the actual cost to the state approximates 20 percent.

Economic conditions in the state of Nevada are such that work could be commenced within a very short time after federal funds became available, for it is believed that there are enough highway contracting organizations, properly equipped both financially and mechanically, to perform the necessary construction, without imposing any undue burden or strain upon out-of-state organizations by calling them in to help in the road construction program.

Because Nevada has no very large cities located along the proposed strategic network bringing necessary by-passes, and because its industrial units are not of a major character, except in the field of mining and metallurgy which units are usually located in open country, and in view of the fact that no military camps have been set up in the state, problems affecting these phases of the national defense highway network will have no serious obstacles to their successful solution.

New Hampshire

In New Hampshire we will go along expending our federal aid allotment, improving such highways as have been designated as strategic. The amount, of course, that we can expend is limited to appropriations which, roughly, is one million and one-quarter dollars a year. The estimate for New Hampshire to put these roads in condition is around twenty-seven million dollars.

Unless there were a special appropriation by Congress it would be some time before we could get them all up to the standard required. This next year we will devote the major part of our federal funds to rebuilding weak bridges on this system.

New Jersey

Information concerning defense highways in New Jersey must merely be an estimate until some more reliable, and more definite information is made avail-

able. We are still unable to say what may ultimately be required in this respect.

There appears to be some 761 miles of highways under the jurisdiction of the state highway department which are included in the system designated by the War Department as of special importance to national defense, 344 miles of which are considered of primary importance and 417 miles of secondary importance. Furthermore, there are some 36.2 miles of primary and 20.1 miles of secondary roads included in the system which are not under the jurisdiction of the state highway department.

A survey shows that in order to bring this mileage up to the minimum War Department specifications would require the improvement of 98.7 miles of primary highways together with the construction, widening or strengthening of 23 bridges at an estimated cost of \$3,798,600, and the improvement of 63.6 miles of secondary highways with the construction, widening or strengthening of 15 bridges at an estimated cost of \$1,926,700. (This does not include access roads to the several camps, forts, arsenals, airports, etc., upon which no conclusive determinations have as yet been made.)

The minimum specifications of the War Department for its strategic defense network are far below peacetime requirements in the great industrial and commercial centers of the East, and particularly in New Jersey, lying as it does between the great metropolitan centers of New York and Philadelphia. The New Jersey State Highway Department feels that the proposed Boston-Washington Highway to connect the industrial, commercial and population centers of the eastern seaboard would be of tremendous military significance and would likewise be of great advantage towards promoting economic progress. This project in New Jersey, depending on the ultimate line of location and its terminal points in New Jersey, is estimated to cost from \$61,000,000 to \$98,000,000. A large part of this project is justified from an economic standpoint at the present time.

New Mexico

Roads designated as important to national defense in New Mexico have a combined length of 1,105 miles. Of this mileage, approximately 150 miles have been built to a standard which meets the minimum War Department requirements. The balance, namely 955 miles, must be cor-

rected or rebuilt to meet the minimum requirements.

Standards of construction in use in New Mexico in the past fifteen years, during which period most of the mileage designated as a part of the strategic system was built, have varied from a width of 24 feet (16-foot surfaced section with 4-foot shoulders), to our latest design of 32-foot width (22-foot surfaced section with 5-foot shoulders). Approximately 50 percent of the 955 miles to be improved to military standards has been improved to a width of 32 feet and all structures are adequate to meet minimum load requirements.

In planning for the improvement, or correction necessary to meet minimum War Department requirements, approximately 200 miles have been selected to be completely rebuilt. This work is located so as to eliminate obsolete sections which, by reason of their low standard of design, and other objections, cannot be handled satisfactorily other than by being completely re-built. It is planned to handle this work entirely by the contract system, and it is estimated to cost approximately \$6,000,000. On the 755 miles remaining, the work contemplated consists, for the most part, of widening fills and cuts to provide a minimum shoulder width of 10 feet on either side of the roadway, and to provide either gravel or crushed stone surfacing for this 10-foot width, and to extend minor drainage structures to accommodate this extra width, major structures to be widened where width is less than 20 feet. The total estimated cost of this work, as planned, is approximately \$4,200,000.

In addition to the work above described, it will also be necessary to make provision for by-passing several cities and towns. Studies are now being made to determine the number of by-passes necessary, and how the work should be planned. As soon as this information is available, it will be submitted to the proper authority for review and recommendations. Estimates of the probable cost of this work are not yet available, but it is apparent, from such information as we have at hand, that this work will cost between \$2,000,000 and \$3,000,000.

The design requirements set up by the War Department for defense roads, so far as New Mexico is concerned, do not require anything which we would not like to have, or which we would not consider desirable for peace time use. The work necessary to bring our roads up to this minimum requirement will, how-

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ever, work a great hardship on our state if no other provision for the necessary funds is made other than the regular federal aid money allotted to New Mexico.

It is the desire of the New Mexico State Highway Department to cooperate in every way possible in the construction of roads on the strategic network. However, we believe that, due to the financial limitations of our state, funds in addition to the regular federal aid allotment should be made available for all improvements which are of more importance to military operations than to peace time use. We are definitely opposed to the expenditure of any of our regular federal aid allotment, or state funds, on roads which are of no commercial value to the state, or which are for military use only.

New York

To bring that portion of our state system designated on the military network of roads, established as of August 1, 1940, up to minimum requirements, is estimated to cost \$52,000,000. This figure includes the widening and strengthening of pavements, the construction of wide shoulders and the reconstruction of inadequate bridges on the military system.

The estimated cost of similar improvements on suggested additional routes for the military system is \$8,000,000.

Estimate for construction of necessary by-passes around upstate cities and villages is \$38,000,000.

Estimate for construction of necessary arteries in New York City is \$40,000,000.

It is also estimated that the cost of additional rights-of-way necessary for the above mentioned construction would amount to \$9,000,000 for upstate and \$18,000,000 in New York City.

Summarizing the above, we find that the estimated cost of construction upstate is \$98,000,000 and in New York City \$40,000,000, a total construction cost of \$138,000,000, while the right of way cost of \$9,000,000 upstate and \$18,000,000 in New York City make a total right of way cost of \$27,000,000.

Therefore, the estimated cost of improvements to our highway system to meet military defense requirements is \$138,000,000 for construction and \$27,000,000 for rights of way, or a total of \$165,000,000.

North Carolina

The highways in North Carolina which the War Department determined to be of strategic importance of first, second and third priority in connection with the national defense program comprise 1238 miles. The cost to bring these highways up to the minimum standards set up by the War Department has been estimated at \$3,733,200. This is based on only widening the shoulders on such of these highways as are less than 8 feet at present to a minimum width of 8 feet at 2,000-foot intervals for every two miles on each side of the roadway. At the time we prepared this estimate it appeared that plans were being made to use regular federal aid funds to bring these strategic highways up to the minimum standards required by the Army. We realized that if the work was handled in that manner it would require a much larger percentage of state funds than federal aid to take care of this work.

This commission does not feel that the shoulder widening required on these strategic highways will be of any material benefit to the motorists at large and, therefore, that the funds needed for this standardization work should be secured largely from federal appropriations. I am personally very much interested in the

national defense program but I consider that proper roads over which to move the motorized equipment are most important, under the present technique of Army maneuvers. The roads are the only part of the national defense program which will be of definite value to the people at large after the war is over and for that reason it is felt that while the government is spending billions of dollars in national defense they could well afford to spend a few hundred millions in improving certain strategic highways so as to make them efficient as an arm of the Army in transporting motorized equipment and troops.

The total cost of \$3,733,200 to bring these roads up to the minimum standards set up by the Army authorities is divided as follows:

19 bridges of inadequate capacity to be rebuilt at an estimated cost of	\$ 940,000
30 bridges to be widened and remodeled at an estimated cost of	922,000
Estimated cost of shoulder widening	228,600
Estimated cost of widening surfacing	1,534,600
Estimated cost of relocation	108,000
Total	\$3,733,200

Please bear in mind that these estimates are based on minimum requirements and it is believed that in order to do an adequate job to bring these highways up to the proper standards as strategic highways would involve upward of \$10,000,000, not including the cost of constructing by-passes around cities and other congested areas. The cost of the necessary by-passes around these congested areas in order to expedite the movement of equipment and troops is estimated at more than \$5,000,000. The estimated cost of constructing access roads to Army camps in the state will approximate \$2,500,000. The funds available from both regular federal aid and state are much inadequate to take care of such a program and it should be remembered that whatever work is to be done in standardizing these strategic highways should be taken care of as soon as possible as otherwise it may be too late.

North Dakota

The strategic network in North Dakota should contain three highways totaling 926 miles. All of the projects built on these three routes during the past four years are up to required standards for military use, other than width of surfaced shoulders which would have to be constructed for the entire mileage wholly or in part. Structures are adequate on the new sections and only one major bridge is necessary for reconstruction, and that is planned for in the regular federal aid program for 1941.

The estimated cost of reconstruction of the obsolete sections and the construction of surfaced shoulders for the balance of the mileage is \$21,000,000. It is not possible for North Dakota to finance any part of this cost other than the comparatively few short projects which are properly a part of our regular federal aid program for 1941 and 1942. At the present time we are two years behind in matching available federal aid due to the lack of state funds for this purpose, and there is no possible way to improve this situation.

Although the economic condition in North Dakota has improved greatly during the past two years, the road user taxes are now as high as the people can afford and it is therefore impossible to work out any further plan of financing that will provide for matching federal funds on this system of military roads.

The proposal to require the states to program all

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CHAPTER 13. STABILIZATION OF BASES AND SURFACES—This chapter is devoted chiefly to work with calcium chloride, articles on portland cement and bituminous stabilization being given in the chapters on concrete and bituminous construction.

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federal aid funds on the strategic network of military highways does not seem feasible in general, and although this opinion may be based somewhat upon the situation in North Dakota, certainly the same conditions prevail in other states and the completed defense program will involve federal funds for highway modernization, such funds to be available without any percentage of matching by the local authorities.

Ohio

Ohio's minimum military highway requirements are in excess of \$36,000,000.

This is \$24,000,000 in excess of the amount the state would normally spend in the next five years including federal aid funds.

The \$36,000,000 would include shoulder widening, new construction and widening and reconstruction but does not include building of roads to civil requirements or standards.

The \$36,000,000 includes construction already programmed or planned on the military system.

In addition there would be a minimum of \$5,000,000 needed for access roads to military bases, airports and industrial areas serving military requirements.

Rhode Island

Rhode Island has 1,206 miles of highway on its legally designated state highway system of which 795 miles have been constructed and are maintained by the Division of Roads and Bridges.

The War Department of the United States recently designated a network of roads as being vital to national defense and the following data shows facts pertaining thereto:

The mileage of roads under our supervision of primary importance to national defense is 64.6 miles, while a classification of secondary importance amounts to 10.9 miles; or a total of 75.5 miles.

An estimate of mileage on this selective system as of immediate concern for improvement on the first, or primary group which needs rebuilding, relocating, or widening is 18.7 miles at an estimated cost of \$1,889,200. On the secondary group this work amounts to 10.9 miles at an estimated cost of \$522,840. One new bridge estimated to cost \$800,000 will be required.

Out of 398 bridges on the system six may be considered as obsolete, one of the six being indicated in the above.

Substantially all portions of the constructed state highway system meet or exceed the minimum requirements.

Work is now being prosecuted to modernize such portions of the primary strategic network which have not at least four traffic lanes, and also on access road projects to military reservations.

There is an adequate number of qualified contractors available at present to do the work required as noted above.

The legislature, which convened on January 7, will pave and flexible type bituminous pavement.

South Dakota

The strategic military network as laid out in South Dakota embraces what is most generally known as the main artery east and west across South Dakota and which, at this date, is carrying the greatest amount of traffic across the state from the standpoint of foreign traffic as well as local traffic. This east and west trunk highway is designated as the road of first priority upon the strategic network.

This embraces total of 446.4 miles. This entire mileage is paved with the exception of approximately 10 miles which is under construction at this time and one short section of 4 miles which will go to contract this coming season. This mileage of first priority on this strategic system embraces approximately 100 miles of concrete pavement and the balance of flexible type bituminous pavement. Although none of this existing highway has a finished surface of less than 24 feet, there is much of it of the very old and low-grade type of construction.

In order that it shall be improved to a standard in line with recommendations made for improvement of projects upon this strategic network, it will require approximately \$6,500,000 for grading construction and approximately \$850,000 to widen existing bridges. In the mileage set forth of 446.4 miles, three will be approximately 150 miles of reconstruction involving this rather than improvement of the existing grade. It would not be wise to attempt to widen the existing grade on this mileage for the reason that the type of construction that exists embraces a great number of bad curvature conditions as well as many bad vertical curves with limited sight distance. It would be impractical to try to improve these with reconstruction.

The continuing program for improvement with federal aid which the state is carrying forward from year to year with all available funds it has for this type of work has been gradually from year to year working out some of these bad situations. Of course, with the limited funds that South Dakota has it is not possible for it to take on a program as large as is set forth above in any short period of time.

The mileage represented as of secondary priority in this strategic network embraces 594.5 miles. This represents two north and south roads across the state with the exception of one short stretch of east and west trunk road which makes a vital connection to the east and west route mentioned above. Quite a good portion of this mileage of second priority is now improved to a standard comparable to that on the first priority representing quite a good mileage of concrete pavement and flexible type bituminous pavement.

To bring the mileage represented in the secondary priority on the strategic network up to adequate width and surface treatment with either concrete or bituminous surface, it is estimated that this will require \$7,700,000 for grading and surfacing and approximately \$1,000,000 for bridge construction and widening.

The estimate of this department for the improvement of third priority mileage is approximately two million dollars for grading and surfacing construction and approximately 250 thousand dollars for bridge construction and widening.

The policy of the highway department is to give service to as many areas as possible in the state with the funds available based upon the earning value of the roads improved and areas served by such improvement. It is not possible for the department with its limited funds to continue to make improvement upon its system as a whole and concentrate all of its funds upon the strategic network. The necessity for the concentration, however, depends upon the status of the defense program and its urgency with reference to the relationship that this maintains in the next months or years. That question, however, is entirely out of the hands of this department as we are looking only to the problem of building roads.

(To be concluded in February)

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MODERNIZING AN ICE CONTROL SYSTEM

Details of Methods and Equipment Which West Virginia Has Found Advantageous

By E. L. WORTHINGTON

*State Maintenance Engineer
West Virginia State Road Commission*

ICE control methods in West Virginia underwent a thorough revision last year and, as a result, motorists enjoyed the safest winter highways in our history, despite an unusually severe snow and ice season. Where previously attention had been given only to sharp curves and steep grades, under the new plan skid protection was extended to include all slippery highway sections whether on curves, hills or tangents.

Expenditures for Snow Removal and Ice Control during the period from October, 1939 through April, 1940 totalled \$235,428.50 a considerable increase over the 1938-39 figure of \$107,408.10. The additional expenditure is very well justified and represents money used to advantage when recognition is made of the fact that, in addition to increased snow removal operations, 4,222 miles of highways were treated (most of the 4,222 miles many times during the winter season) using 49,565 cu. yd. of abrasives, and also that considerable amount of equipment was acquired for use under the new ice control plan. The severity of the winter is indicated in our records, which show that maintenance crews were at work 24 hours daily in some section or other of the state from December 27, 1939 through January 30, 1940, and temperatures fell to as low as 20 degrees below zero. These conditions are unusual for our section of the country.

Essentially, the system we have adopted to prepare for and combat the ice hazard involves (1) The storage of abrasives in large bins so constructed that loading of trucks is practically automatic, (2) Chemical treatment of abrasives to prevent freezing in storage and



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to insure rapid embedment when spread, (3) The use of mechanical distributors for application of abrasives, and (4) Expansion of ice control service to include greater road mileages and skidproofing of all slippery sections regardless of location.

Storage of Abrasives

In the past, we had followed the common practice of storing abrasive materials in numerous stockpiles at wide spots alongside the road, placed where possible near curves, hills and other danger spots. Usually these piles were not treated to prevent freezing. When ice conditions arose, trucks set forth empty from the County and Sub-county headquarters and, over slippery roads, proceeded with difficulty to the nearest stockpile. A crew of men with hand shovels dug into the often-frozen stockpile and eventually succeeded in loading the truck. Spreading was then ready to begin, but a considerable portion of the abrasives loaded were in the form of frozen chunks therefore of minimum effectiveness. Since ice control operations start with the loading of abrasives, a delay here is reflected all down the line.

To overcome this initial cause of delay, we have constructed, within easy reach of the various county headquarters, large wooden storage bins of 100 to 150 cu. yd. capacity. Wherever possible the bins have been erected at locations which permit dumping of the abrasives directly from trucks into the top of the bin and re-loading of trucks by gravity from the bottom of the bin. The topography is such in West Virginia that little difficulty is experienced in finding sites that permit this

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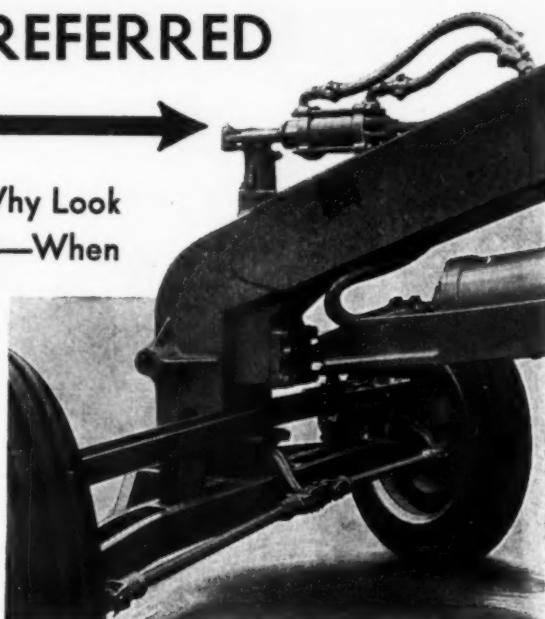
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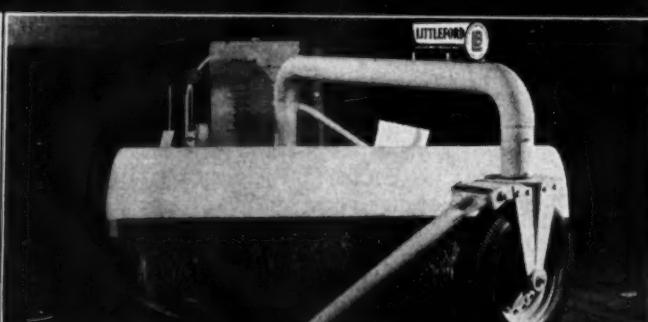
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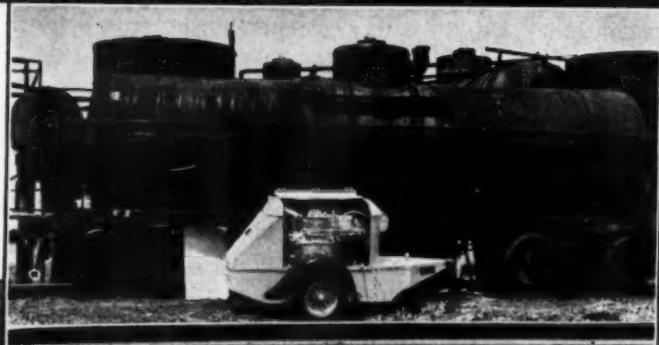
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West Virginia Spreader in Operation

nature of bin construction. Where side-hills are not conveniently located, however, we have arranged suitable loading facilities by means of ramps or, in a few cases, by using bucket elevators.

Trucks are loaded from these bins within a fraction of the time required for hand-loading, and are out on the roads spreading shortly after the dangerous ice condition develops. When the trucks are empty they can quickly return over the skidproofed surface to the central storage bin or proceed to other outlying bins.

Last winter we erected 13 of the large bins and, having proved their practicability, we expect to have at least 75 in use by the end of 1940. Some of these bins will be of smaller capacity—from 25 to 50 cu. yd.—and will be located at strategic points such as at mountains where ice control operations are required most frequently.

Cost of the bins has varied considerably in different sections of the state, since, in some instances, we have been able to make use of salvaged lumber from old coal tipplers, etc., while in others nothing but new lumber has been available. In all cases, however, the bins have been of sturdy design, and divided into several compartments to increase their year-round usefulness. The past summer showed them to be ideal for storage of different sizes of aggregate used for road surfacing and patching purposes.

In a few isolated places, it probably always will be necessary to maintain stockpiles of abrasives alongside the road, but we intend to keep them to a minimum. Even here, we provide added protection by covering the stockpiles with the empty calcium chloride bags after the chemical treatment has been made.

Types of Abrasives

As appears to be the case in most other localities, our experience in West Virginia has shown cinders to be the most effective abrasive for skidproofing; but since abrasives must usually be selected on the basis of local availability and cost, we have been compelled to make use of other materials in certain areas. Our records show, for the winter season of 1939-40, that we used 34,639 cu. yd. of cinders, 2,410 cu. yd. of sand,

9,059 cu. yd. of sawdust, 1,550 cu. yd. of red-dog, and 1,907 cu. yd. of slag. Sand is obtained in our state by crushing down the soft sand-stone found in some of our mountain formations. Where cinders are too large to be suitable, we also employ the crushing process.

Experimenting with mixtures of the various types of abrasives in sections where we desired to conserve a particular kind, we found that quite satisfactory results could be achieved with a combination consisting of 25 percent sand, 50 percent cinders and 25 percent sawdust, chemically treated. Consequently, it will be noted that we were able to make use of over 9,000 cu. yd. of sawdust—a material that we can secure most reasonably due to logging operations in the state.

Chemical Treatment of Abrasives

To protect the investment made in abrasive materials for ice control, we have found chloride treatment entirely justified from an economic standpoint alone. Untreated materials are not only subject to freezing in storage, but are easily whisked off the road and into the ditches by wind and traffic. Chemical treatment enables the grits to flow freely in loading and spreading at any temperature, and also imparts a melting action that serves to anchor the particles in icy surfaces.

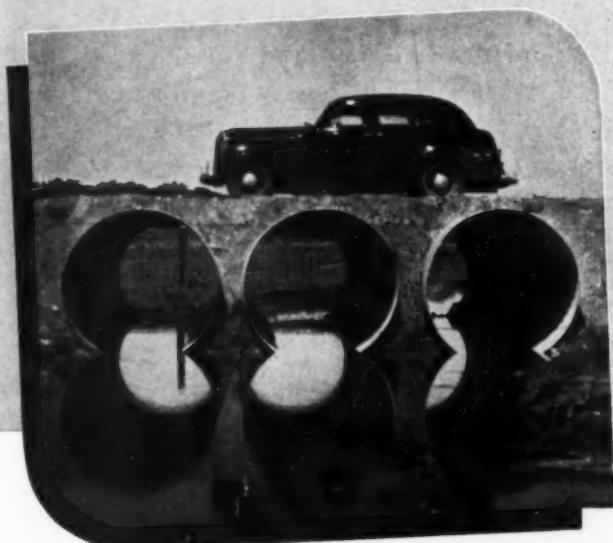
We add the chloride to the abrasives as they are being placed in the storage bins, making treatment at a rate of 50 lb. per cu. yd. of abrasives. It is important to mix the chemical thoroughly with the abrasives as they are being stored, and we have found that this is best done by spreading the proper quantity of chloride for the full truck load directly on top of the abrasives, allowing the mixing to take place as the abrasives are dumped slowly into the storage bin. Since some moisture is necessary to dissolve the chemical, the bins are constructed with a detachable cover or roof to permit the entry of rains or natural moisture until solution is complete. If immediate dispersion is desired, the moisture can be quickly supplied by means of a hose from a portable water tank.

During extremely cold weather, we have found it advisable to increase the rate of embedment of the abrasives by an additional chemical treatment as they are being unloaded from the bin. When this re-treatment is necessary, the chloride is again spread entirely over the top of the truck-load, to be mixed as the material runs into the spreader. If the abrasives are moist as they come from the bin, no additional chemical is needed. Even when they are pretty well dried out, it is very seldom that we have found it necessary to use



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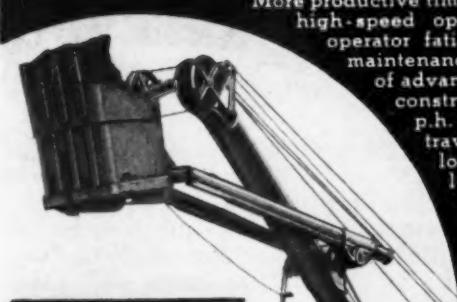
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more than 50 lb. of chloride per cubic yard for the re-treatment.

While we mix the chemical with the abrasives for all ice control operations on the open highway, we have found that state routes through municipalities can be most satisfactorily de-iced by applying a solution of calcium chloride directly on the ice surface. Application of the chloride is made through a bituminous distributor and softens the ice so rapidly that it soon breaks up and melts under traffic. We believe that this method is cheaper and more effective than abrasive treatment in the case of city work, as the action is extremely fast and there is no residue left to clog drains and catch basins.

Mechanical Application

To derive maximum benefit from our improved storage and loading method, and from the easy-flowing treated abrasives, we are eliminating hand-spreading of abrasives and equipping our trucks with mechanical distributors as rapidly as possible. Last winter 123 of our trucks were provided with mechanical spreaders and, by the end of the present season, we expect to have from 250 to 300 in operation.

Where abrasives are spread by hand, the cost of labor is about tripled, the spreading operation is slow and wasteful, it is impossible to do more than a mediocre job and, furthermore, the work is extremely disagreeable to the employees. The men in the shovel crew, quite probably working in the dark, with cold fingers and buffeted by wintry blasts, must maintain their balance on moving trucks and at the same time attempt to scatter the abrasives in such a manner that they will cover the icy surface as evenly as possible in the proper amount to give the desired skid-proofing effect. In addition they must be careful not to throw the material on passing vehicles. It is obvious that these men have a tough assignment and cannot be blamed if much of the abrasive goes wild. Uniform distribution is impossible, so it is necessary to spread an excess of material to be certain there is enough to have the desired effect.

The cost of equipping our ice control trucks with mechanical spreading equipment has been kept to a minimum by constructing the spreaders and the truck tail-gate dispensers in our own shops. Cost per truck has ranged from \$75 to \$100 for spreader, dispenser, reflector, etcetera.

The spreader consists of a disc spinner driven by the gear action of a Model A Ford differential with the gears locked to make them work as one unit. We have been able to buy these differentials with the axles from junked auto yards at an average cost of \$5.00. On the axles we mount a set of small size wheels with 4.00x12 pneumatic tires at a cost of around \$15.00. A hopper is constructed of 8-gauge metal directly over the disc spinner and the unit is strengthened by liberal use of angle irons. For warning to motorists, we attach a 3-inch Stimsonite red reflector on the hopper.

To deliver the abrasives from the truck into the hopper of the spreader, we have devised a special dispenser that fits into the truck body, replacing the original tail-gate. As shown in accompanying photographs, this dispenser consists of a new tail-gate, designed to serve as a platform, with side panels attached to funnel the abrasives toward the slide-opening which controls flow to the spreader. The side panels wedge into the truck-bed and are further secured by means of metal rods, fastened to the sides of the bed, these rod braces also serving as a safety railing for the workmen. Chains

are used to support the working platform in the same manner as is employed with standard truck tail-gates. The spreader unit is also fastened with chains, adjusted so that when the truck-bed is down the spreader wheels are lifted off the road, and when the bed is hoisted the wheels are on the ground ready for spreading to begin. All of the equipment necessary for mechanical spreading can be installed on an ordinary dump-truck by two men in less than 10 minutes. Red lights are mounted on each end of the spreading platform and, to give still further warning, we are providing blue

West Virginia Storage Bins with Three Different Means of Access for Trucks Delivering Abrasives to Them



Bin with Inclined Trestle Approach



Bin with Graded Ramp Approach



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flasher lights with front and rear lenses on top of many of the truck cabs this year.

In operation, two men are used on the back of each truck, to regulate the flow of abrasive material into the spreader hopper and to keep the material moving in the truck bed. Each man stands in his own corner of the tail-gate platform and is protected against falling by the side panel at his front and cross-braces at back and side. The truck operates at a speed of 10 to 14 m.p.h., and the rate of application is controlled by the slide-opening in the dispenser. Where traffic permits, the truck travels down the center of the road, spreading a 10 or 12 foot lane of treated abrasives. The natural crown in the road, plus the action of traffic works the abrasives over the entire road surface.

When it is realized that a speed of 3 m.p.h. is just about maximum where spreading is done by hand, it is readily apparent that mechanical spreading is a necessity from the standpoint of speed alone. The spreaders, we have found, are also very useful for application of fine road surfacing material in summer maintenance, and so are adaptable for all-year use.

Extension of Winter Maintenance a Social and Economic Necessity

Back in the days before the automobile, the radio, the movies, there was a much sharper line of distinction between the rural and urban dweller. The man who lived in the country was a farmer and usually prepared for winter in the same way as a squirrel—by laying in supplies to carry through until spring. If an occasional trip to town was necessary, it was made when weather conditions were favorable to use a wagon or sleigh.

The man in the city was quite self-contained, too, and had arranged his habits to conform to circumstances. Fresh fruits and vegetables in the wintertime were rare. Merchants' stocks were built up high, and warehoused, since "drummers" seldom came through in winter and deliveries could be made only by rail. The city dweller worked and played within the city limits.

Growth of the nation's highway system and the need for year-round auto travel has changed the picture, and open winter highways—both primary and secondary—have become a sheer necessity, essential to the country's prosperity and well being.

Decentralization of the population—deemed a necessity by economists—has been emphasized quite heavily during the past few years, with the result that a considerable number of city industrial workers have moved into rural locations on so-called "small farms," usually situated on secondary roads. If these people were unable to get back and forth to work freely—in winter as well as summer—this manner of life would be impossible and its benefits, both to individuals and the city, would be lost.

Consolidation of rural schools has brought better educational facilities to the country at lower cost but, for the system to operate satisfactorily, buses must be able to move on schedule the year around.

Many of the smaller towns and villages are entirely dependent upon open highways for daily deliveries of foodstuffs and other merchandise. Inter-city transportation, too, requires rapid movement of motor freight, and business is seriously crippled when delays occur due to closed or unsafe highways.

Located as we are, our state is in the direct route of many tourists going south for winter vacations. The revenue thus derived for our hotels, restaurants and service stations is an added incentive for us to keep our highways open and safe.

To speedily and efficiently perform an adequate job of ice control is a challenge to the resourcefulness of any highway department. Without modern methods and equipment, the battle is lost before it starts. This is why the West Virginia Road Commission is taking advantage of every facility that will further improve and extend its winter maintenance program.

UNIFORM TRAFFIC CODE FOR OHIO

Elimination of the erule-of-thumb practices prevalent today in driving an automobile in Ohio is proposed in a "uniform traffic code" which is to be laid before the current session of the legislature.

Standardization of all driving practices, in cities and villages, on county and township roads, in conformity with the principles already established on the more than 18,000 miles of state system highways, has been written into the bill.

Sponsored by the Ohio Traffic Safety Council, educational division of the Ohio department of highways, and backed up by the public in numerous polls taken over the state, it is the belief that the legislature will go forward with the program to remove all guess-work from motor car operation.

OPERATING REVENUES OF TRANSPORT AGENCIES

The following tabulation from the Information Service of the National Highway Users Conference shows the operating revenues of various classes of transport agencies for the 12 months ended June 30, 1940:

Class of Carrier	Amount ¹	Per Cent of 1937
Steam railways	\$4,339,000,000	100.42
Railway Express Agency ²	114,779,000	104.71
Pullman Company	60,242,000	93.78
Water lines	110,200,000	101.59
Pipe lines	218,263,000	87.78
Electric railways	51,000,000	88.74
Motor carriers of passengers ³	175,000,000	123.20
Motor carriers of property ³	940,000,000	128.78
Total	\$6,008,484,000	103.93

¹ Partly estimated.

² Excludes payments to other carriers for express privileges.

³ Based on class I motor carrier reports with an allowance for smaller carriers.

DIVERSIONS REACH NEW HIGH IN 1939

Figures released by the Federal Works Agency shows that the highway users paid into the state treasuries \$1,252,205,000 in special motor vehicle imposts during the year 1939. Of these revenues, \$181,654,000, or 14.8% of the total, was expended for non-highway purposes—a material increase over any previous year. These figures do not include special levies by counties and municipalities. Nor do they include real and personal property taxes, sales taxes, or Federal excise taxes, totaling upward of \$600,000,000. The item of tolls, variously estimated as close to \$100,000,000 is also left out.

To date voters of eleven states—California, Colorado, Idaho, Kansas, Michigan, Minnesota, Missouri, Nevada, New Hampshire, North Dakota and South Dakota—have resisted the diversion of highway funds by ratifying constitutional amendments protecting such funds. Similar amendments are pending in several states.

NEW BOOKS

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Second Edition

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Publishing Director, ROADS AND STREETS

and
D. G. Runner
Assistant Materials Engineer,
U. S. Public Roads Administration



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Missouri State Highway Department

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U. S. Public Roads Administration



This book is reprinted from a series of articles published in ROADS AND STREETS. Demand for the series was world wide. The book treats of fundamentals of soils mechanics and soil stabilization such that the average engineer can get a complete understanding of this new branch of highway engineering.

It is the best treatise on the subject so far published, and is a vital need for the engineer who is considering low cost road improvement or grading embankment control.

Profuse illustrations tell more than words could.

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As Related to Highway Engineering

By Delmar G. Runner

Assistant Materials Engineer,
U. S. Public Roads Administration



Rock and soils, and their characteristics, both physical and chemical, as well as their classifications and geographical distributions are discussed in such a way as to make this book particularly valuable for civil engineers and for engineering colleges. The chapters on material surveys, together with those on the petrographic microscope and its use constitute a real contribution to the fund of knowledge on engineering geology. This is the first time that the theories of general geology have been correlated by a competent engineer and geologist with the requirements of highway engineering. The book is written from the engineer's viewpoint for engineers. It puts into usable, understandable language the facts concerning rock formations and gravel deposits hardness or toughness values, how to recognize suitable or undesirable materials, and the source or origin of rock types. It is particularly useful to those engineers charged with the responsibility of materials selection for construction or maintenance work.

CONTENTS

Introduction; Value of Engineering Geology; Road Material Survey Methods; Relation of Geological Formations to Material Surveys; The Common Rock Making Minerals; Igneous Rocks; Metamorphic Rocks; Sedimentary Rocks; Origin and Roadbuilding Properties of Shale; Origin and Roadbuilding Properties of Caliche; Origin and Roadbuilding Properties of Limerock; Origin and Composition of Clays; Preparation and Properties of Blast Furnace Slag; Low Cost Road Surfaces; Petrography and the Quality of Rock; Sand and Gravel Deposits; Soils and Soil Tests; Glossary of Geological Terms; Glossary of Highway Terms; Names and Addresses of Highway Departments; States With Geological Commissions; Testing Material Procedures.

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EDITORIAL

NATIONAL DEFENSE HIGHWAY REQUIREMENTS

HIGHWAY development throughout the United States has been advancing at an ever increasing rate during the past 30 years. The standards used in building American roads have been established largely by the needs of commercial traffic. It so happens that designers of Army ordnance and materiel have paralleled commercial automotive equipment design in size, weight, and speed. The result is that, while there remains an enormous task of road building to be immediately accomplished, this nation has, in its several state highway systems, the foundation for a national network required by a complete defense program.

That which has been the normal rate of construction progress for the past 10 years is not adequate for the defense construction task which confronts us. Progress in the past has been based upon peace time fund availability and plans for development over a long period of years. The demands upon a highway system tuned to the tempo of other phases of the national defense are far greater and more urgent than those normal progress peace time demands. Trained armies with the most modern equipment and munitions cannot strike effectively if adequate highways are not available for moving them promptly to any destination and serving them while there.

In collaboration with the War Department, the Public Roads Administration is estimating the cost of and the need for highways in the nation for defense purposes. It has been definitely determined, as a result of this collaboration, that "military requirements would impose no standards for roads or bridges superior to those that would be required for the accommodation of normal commercial traffic." The Public Roads Administration was charged with the task of producing a report on national defense highway needs. This report, while long promised, has not as yet appeared.

The writer understands that it may soon appear as a progress report containing recommendations regarding national defense highway needs. Conditions are changing so rapidly that a complete report is not possible. This report will probably deal principally with access roads to camps and industrial plants, and to bottlenecks within municipal borders. Specific and detailed cases will probably be cited.

Elsewhere in this issue is a survey of national defense highway requirements made by ROADS AND STREETS. It contains data and opinions in accordance with information which the states had available at the time the survey was made. All but a few of the states were covered. The editors were told by the Public Roads Administration that it does not approve of the release of the survey data; that the data in no way expressed the views of either the War Department or the Public Roads Administration. The writer was told that publication of the information would be misleading and harmful.

After a conference with an officer of the Public Roads Administration at which the writer was again told about

the lack of approval for publication, we considered the value of the survey information from the public's point of view. During the Washington interview the writer was told that when the information was qualified, as will be noted in the article herein, that it would have no meaning. With this the writer could not agree. The information does have meaning since it expresses the views of the states on national defense highway requirements. Of course, if enough money is not available, to carry out the construction indicated, then minimum requirements will have to be changed, a new plan and new specifications adopted. Undoubtedly this is what is in preparation to be announced by the report. Access roads to camps and industrial areas and bottlenecks within cities and towns will probably receive consideration for extra federal appropriations in the report.

The survey has meaning in that it particularly shows that the states do not favor confining all of their federal aid and state funds on the strategic network. It also shows that the states will need large federal appropriations for defense highway work.

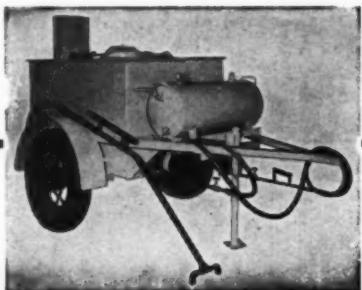
The Public Roads Administration felt that a demand upon Congress for such large sums would be interpreted by the President as an attempt at a "grab" in the name of national defense. It appears to the writer that such an interpretation would be unjustifiable since published hearings before the House Roads Committee has already shown that even larger sums are needed for purely peace time civilian traffic accommodation. And these expenditures are necessary on practically the same roads as are included in the strategic network.

At this writing the states are now totally in the dark as to War Department and Public Roads Administration recommendations regarding national defense street and highway requirements. They can do nothing on a specific program until this information is made available.

BE PATIENT

PRODUCTION of necessary materials "for the greatest interest of the nation" will be given preference over manpower requirements as the armed forces of the nation are increased. It is wise, therefore, for employers and workers alike not to become "unduly anxious" about occupational deferment of employees from training under the Selective Service Act. Occupational deferments, each of which will be determined on an individual basis, rests with the local boards. The Act, the Regulations, and the Selective Service System establish all necessary provisions and procedures to safeguard the interests of the workers, the employers, the local community, the families of registrants and the interests of the Nation as a whole. In this case, patience is a virtue.

Requests for occupational deferments of men in key positions should be postponed until such registrants have received questionnaires from their local boards. Employers have five days after the questionnaire is mailed in which to file a deferment request.



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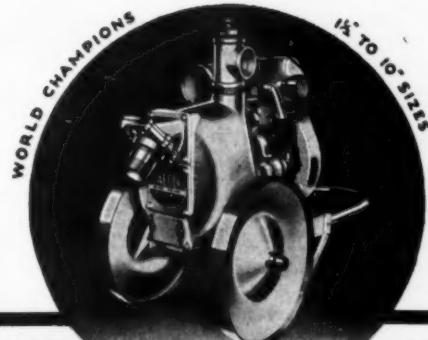
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Highway construction involves more dirt moving than any other branch of engineering construction. ROADS AND STREETS, the only national engineering construction magazine devoted exclusively to, and covering all sections of, the highway field is the most effective and economical medium through which to sell dirt excavating, grading and hauling equipment.



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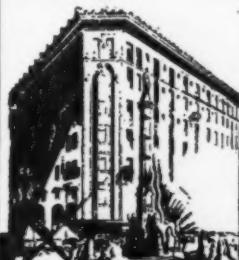
- JAEGER "PRIMING JET"—Up to 5 times faster priming and re-priming—often means difference between profit and loss on job. No adjustments—no need to "gun" engine.
- POSITIVE RECIRCULATION CUT-OFF—It's controlled by flow, not pressure.
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JAEGER "Sure
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CHICAGO, ILL.

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Western Mfrs. and Distr's.

NEW EQUIPMENT and MATERIALS

Bucyrus-Erie New 1/2 Yd. 15-B

Bucyrus-Erie announces the development of a new $\frac{1}{2}$ yard excavator machine 15-B, which can be easily converted in the field from shovel to dragline, and crane to drag shovel. Designed along the same principles of the $\frac{3}{8}$ yard Bucyrus-Erie 10-B, this new earth mover features sustained output at low operating and maintenance cost. It is equipped with a 54 h.p. gasoline engine, designed to provide peak efficiency under rapid load fluctuations—both Diesel and electric power are also available. With

direct-action clutches the operator can get the "feel" of the load and smoothly control every phase of machine's fast digging cycle.

The planning engineers have simplified the construction of the 15-B. To effect a more easily convertible unit, the front-end has been simplified for boom changes, and with the addition of a crowd chain unit no clutch or brake changes are necessary. The design eliminates the center pintle by use of the "built in" conical hook rollers which distribute lifting and swinging loads over a wide area.



Bucyrus-Erie 15-B

Parmanco HORIZONTAL DRILLS



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**Parmanco Drills have convinced
owners of their true value—**

**In the Coal field, the Iron range, the
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Submit us your drilling problems.

We build a model for every need.

Parmanco Drills are now in their fourth year of successful operations.

WRITE US YOUR DRILLING PROBLEMS.

PARIS MANUFACTURING CO., INC.
PARIS, ILLINOIS

Controls are large, cool running clutches with changeable parts, self-adjusting for temperature, and with an easily set single point wear adjustment. Steering clutches, a single digging lock lever, and the boom hoist lever are conveniently located and within easy reach of the operator. Anti-friction bearings reduce friction losses. All gears, except swing and pinion, are completely enclosed and run in a bath of oil.

Simplicity and rugged strength predominate in mounting and propel machinery design on the 15-B. Sixteen-inch treads provide an area of 21.5 square feet. Wider treads are available. The single casting which combines the truck frame, the internal swing rack and hook roller path permits compactness which not only adds to strength but also lowers overall height.

Literature is available by request to the manufacturer or through ROADS AND STREETS by referring to.....RS113

International Introduces Five New Heavy-Duty Truck Models

Features of five new heavy-duty truck models now being shipped from the International Harvester works at Fort Wayne, Ind., include new styling; new cab comfort; new foam-type, sponge-rubber seat cushions; easier steering; new, improved



International K-11

frame construction; larger, easier-riding springs; new rubber-mounted propeller shaft center bearings; wider and deeper front crossmembers; new engine features; new Hi-Tork hydraulic brakes; and quicker-acting air brakes.

Carrying capacities of the new models—cab, body, equipment, and pay load—range from 10,000 to 18,000 pounds, gross vehicle weights from 14,500 to 27,000 pounds, and wheelbases from 134 to 197 inches. The five new models are powered by five sizes of six-cylinder, valve-in-head, replacement-cylinder engines, ranging from 84 to 114 horsepower.

Steering effort has been reduced as much as 50 percent. The king-pin inclination has been reduced from eight degrees to four degrees, and the use of twin-lever steering gears gives better leverage. In addition, all models have ball bearings at the upper end of the steering wheel tube, and the three larger models have tapered-roller bearings in the steering gear.

Fenders are much heavier and running boards have a molded rubber step plate with a ribbed surface. The front bumper is of channel steel and serves as an additional crossmember at the front of the frame. A new type of telescoping hood support with an automatic latch saves time and effort in raising the hood.

The new cabs have more leg room and head room and improved vision. Foam-type rubber extends from top to bottom of the seat cushion and both the seat and back cushion are individually adjustable. Three-point rubber-insulated cab mountings prevent cab side movement and twist. Other cab features include new-type, highest safety glass, new instrument panel, headlight beam indicator in instrument panel, and a felt base rubber floor mat.

New engine features include the mounting of all fuel pumps on the left-hand side of the engine—away from the heat of the exhaust manifold—as an added precaution against vapor lock; new mechanically-sealed water pump which requires no adjustment; larger diameter distributor; and new-type, universal heat range spark plugs. Further information is available by writing the manufacturer or through R. & S., by referring to RS115

"Pacemaker" Quarry Plant

The "Pacemaker" quarry plant developed by the Universal Crusher Co., Cedar Rapids, Ia., is stated to provide three crusher efficiency using only two crushers. This is accomplished by the use of a jaw crusher for primary reduction and a new "two-in-one" roll crusher which does the



The "Pacemaker"

work of two complete double rolls. One pair of shells has $\frac{3}{4}$ in. smaller diameter than the other.

Secondary reduction is done in two steps: the smaller of the divided rolls giving the initial secondary crushing and the other, or major half, fed from the second deck of 4x8 ft. vibrating screen giving the final secondary crushing. The material can therefore be fed through the roll crusher faster, easily keeping up with the jaw crusher.

A capacity of 100 to 130 yd. per hour of $\frac{3}{4}$ in. material without crowding has been reported by several units so far installed.

The Pacemaker is available in various sizes of jaw crushers and with standard or the new "two-in-one" roll crusher. Further information can be obtained by writing the manufacturer or to R. & S. by referring to RS119

New "White" Concrete Vibrator Equipment

To co-ordinate with the continual improvements of concrete vibrator manufacturers, the White Manufacturing Co., Elkhart, Ind., announces its new electric motorized vibrator equipment with features de-

WIND
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Before They Stop You

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Available in rolls and blankets of almost any width. Inexpensive and durable. Have some on every job!

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Now
WELDED
Rolled Steel
CONSTRUCTION

● Every working day, for 17 years, a Williams 3/4 Yard Bucket has been unloading crushed rock and sand from railroad cars for the Concho Sand and Gravel Co., Oklahoma City. In all that time of heavy duty service, not one penny has been paid for repairs or maintenance. Now a set of pins and bushings is being shipped to start the bucket, as good as new, on another seventeen years of service.

Williams Buckets and Parts are stocked by distributors in all sections of the country.

Send for free bulletins covering Williams Buckets for all types of service.

**THE WELLMAN
ENGINEERING CO.**

7003 Central Avenue
Cleveland, Ohio

WILLIAMS
Buckets
built by WELLMAN



Concrete Vibrator

signed to meet specific needs of some types of vibrations. These new units are produced in models ME-16 or ME-17, 1 hp. and 1½ hp. respectively. They are equipped with universal motors, 220/440 volts, 3-phase current and have V-belt countershafts. To increase speeds from 3450 rpm. to 6800, or as high as 8000 rpm., the same type of countershaft with V-belt and pulley is used as supplied with White engine driven outfits. The use of standard motor enables them to be serviced anywhere. Changes in driving speeds can be made by simply using different size pulleys. The sections on the White flexible drive are interchangeable and can be opened up for inspection. Further information can be obtained by writing to the manufacturer or to ROADS AND STREETS by referring to RS118

The model 20 can also be equipped with "Power up and Power Down" Boom Hoist. A single lever is used to control the functions of boom hoisting, boom lowering and braking. An engine throttle control is also provided allowing the engine to be slowed down over a wide range. Further information and literature is available upon request to the manufacturers or through R. & S. by referring to RS109

New Foote Single Drum 34-E Paver

The successful operation during the past year of the new Single Drum 34 cubic foot capacity MultiFoote Pavers has established this type of machine as highly successful for all types of concrete paving work. The paver has a 34 cu. ft. capacity



Foote Single Drum 34-E Paver

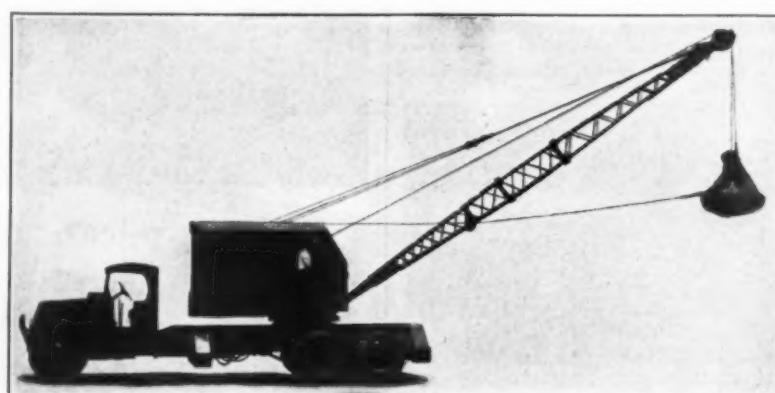
New Northwest Truck Crane

The Northwest Engineering Company, 28 E. Jackson Blvd., Chicago, Ill., is builders of shovels, cranes and draglines, announces that the Northwest Model 20 Crane is now available as a truck crane of 15 tons capacity. This model completes the Northwest truck crane line of four cranes ranging in capacity from 4½ to 18 tons capacity.

The model 20 is equipped with all the standard Northwest features. The "feather-touch" clutch control takes the fatigue out of operation, yet retaining the feel of the load. Swing clutches are of the Northwest standard uniform pressure type which give smooth operation. The Northwest cushion clutch is standard and it is claimed reduces the strains on all parts under power, increasing machine life.

plus 10% on a 6% grade in accordance with A. G. C. Standards—a total capacity of 37.4 cu. ft. The MultiFoote 34-E has been in service during the past year on a wide range of jobs, including boulevards as well as highway work. The illustration shows the White Consolidated, Inc., machine operating on Sacramento Blvd. in Chicago. This machine averaged close to 400 batches per eight-hour day. The I. D. Lain Construction Company machine on a State highway out of Chillicothe, Illinois, last summer averaged approximately 1,000 feet of 20-ft. slab per day.

Despite its increased capacity, the new MultiFoote 34-E is compactly built and is easy to maneuver and transport. For transportation by trailer, the super-structure may



Northwest Truck Crane

be lowered by power after pulling out two pins. The machine is so designed that no water connections or other parts need be disassembled. One contractor has reported that he can make the machine ready for travel by trailer in approximately ten minutes.

This new paver incorporates all the design principles of the latest model of the MultiFoote 27-E paver, which has been widely proved in service. Thus, according to the Foote Company, while the 34-E is an entirely new machine, it has tested principles and actual successful service behind it.

Construction features include a double-cone drum, fully-enclosed travel gears running in oil, Timken bearings on all high-speed shafts, a power take-off consisting of helical cut gears running in oil, a water system which is unaffected by line pressure or a change in grade. Simplicity of design permits easy access to the mechanism. Write to Foote Company, Nunda, N. Y., for further details or to R. & S. by referring to RS112

New Excavating Machine

According to the Osgood Co., Marion, O., their new Osgood Type 20, Model 200, a $\frac{1}{2}$ cu. yd. machine, embodies the latest features of modern engineering design. Machinery is compact, simple and easy to adjust and maintain. It is convertible to any type of service, and designed for various types of mountings, such as crawler, standard truck, and Osgood special wheel mounting. It is powered with either gasoline, or diesel engine.

On the upper deck, there are only two cross shafts; on the lower frame, only one. The countershaft has been eliminated. All vertical shafts: reversing, swing, intermediate, and travel shafts, are recessed in the deck. The main deck casting is of one-piece construction, with all machinery mounted on machined pads.

Clutches and brakes on the swing and travel shaft are controlled by a hand lever at the operator's position. The drum shaft is controlled by Osgood "Servo" mechanism.

The boom hoist is a separate unit, mounted in the left-hand side frame. It has a self-locking steel worm and bronze worm wheel.



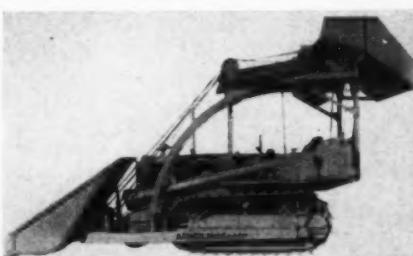
Osgood Type 20

For quick and easy change from Shovel to Crane, etc., the crowding sprocket used for Shovel, and the lagging used for the other types of service, are mounted on the drum in two pieces, eliminating the necessity of removing the drum in making the change.

Cab is of the latest streamlined design, giving all-weather protection and full operating vision. Literature is available by request to the manufacturer or to R. & S. by referring to RS120

New Athey MobiLoader

Designed to be mounted on new or used "Caterpillar" D4 or R4 Tractors, the Athey MobiLoader, manufactured by the Athey Truss Wheel Co., 5631 W. 65th Street, Chicago, Ill., is a new utility tool, designed



MobiLoader

to provide faster, more flexible and economical loading in a variety of uses.

Among the advantages of this equipment, the manufacturer states, is its ability to transport materials without turning to discharge load. The MobiLoader is equipped with an extra-large bucket for faster loading; and this bucket may readily be altered to fit many specific requirements.

Operating experience with the Athey MobiLoader shows that it scoops up the load, lifts it and dumps in a loading cycle of 15-20 seconds.

The Athey MobiLoader is so designed as to allow clear vision for the operator, since there is no structure in front of him to obstruct his view. In addition, the MobiLoader does not interfere with the operation of the tractor tracks, but leaves them free to oscillate normally. Write to manufacturer for further details or to R. & S. by referring to RS121

Universal "Chip-Top" Spreaderoller

Because it combines the operations of two machines, the Spreaderoller, made by the Universal Crusher Company, Cedar Rapids, Ia., is stated to have gone far in cutting road maintenance and seal coating costs.

The Spreaderoller spreads chip in three layers: coarse material first, smaller stones or chips next and finer material on top to fill the voids, simultaneously rolling the spread material with a standard 10-ton roller.

The unit tows a ramp so that trucks can back up on it to empty their loads into the hopper. The hopper holds a truck load.

SPEED UP DEFENSE WITH THIS EQUIPMENT RAPID PAVEMENT BREAKER



SPEED — ECONOMY

FASTEST PNEUMATIC CONTROLLED MACHINE

Breaks frosted ground, concrete roads, bridge decks, trench. Tamping-post hole digging.

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job.

Slopes banks rapidly.

Easily attached to any shovel in an hour's time.

Will cut any slope that a shovel can dig through.

Controlled entirely from operator's seat. Will cut through sand, gravel, soil, clay and broken rock in one operation.

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MOIL POINTS
AND CHISELS

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OF AMERICA**

607 DEGRAW ST., BROOKLYN, N. Y.



"Chip-Top" Spreaderoller

A road base treated with oil can be quickly topped and rolled, the Spreaderoller providing a smooth surface once over.

The Spreaderoller can be steered, is self-propelled and can be used as a road roller where it is not desired to spread chips.

It is not necessary to close a road being sealed as the machine occupies only one-half of the road so that traffic can bypass on the other half. Literature is available on request to the manufacturer or through R. & S. by referring to.....RS122

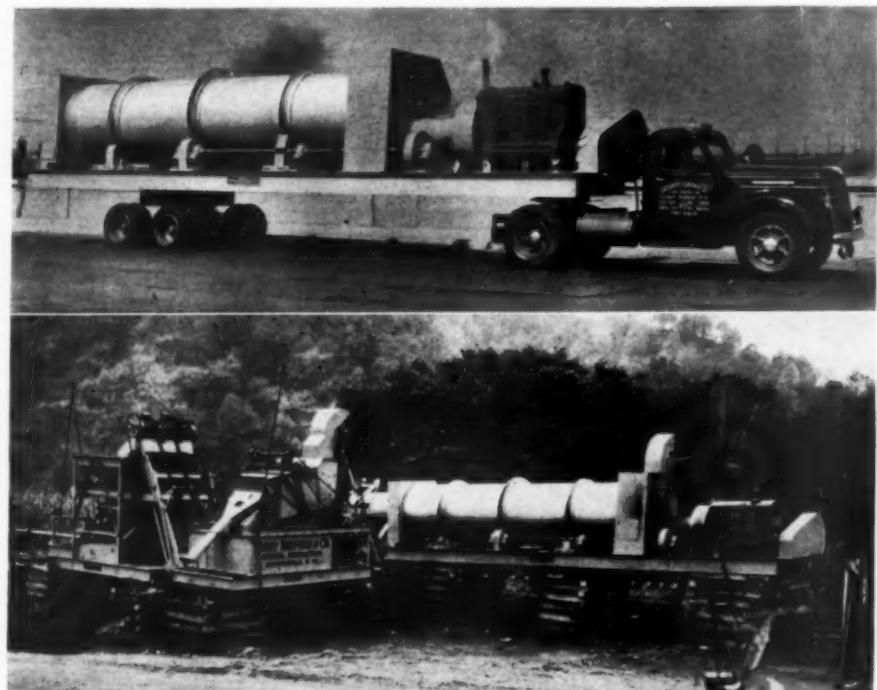
Portable 2500-Pound Bituminous Plant

A new plant built by Hetherington & Berner, Inc., of Indianapolis, Ind., for Harry Hatfield & Co., of Barboursville, W. Va., marks an important development in the bituminous equipment field. The outstanding novelty is the special wheel mount-

ing for the three main units (mixer and weigher, screens and bins, and dryer), which is stated to afford a degree of portability never before attained for a plant of this type and capacity. During operation all

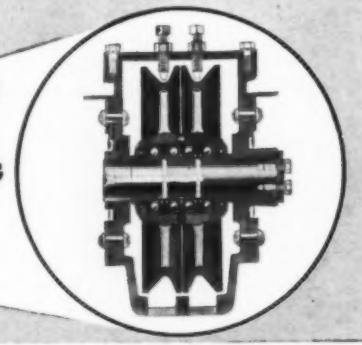
parts of the plant are solidly supported without wheels.

The mixing unit includes a 2500 lb. pug-mill, a 2500 lb. aggregate weigh box and dial scale, Fluidometer system for metering



Below: The Hatfield Plant Set Up at Kitchen, West Virginia
Above: Dryer Unit on the Road

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BUCKETS have
SEALED
BALL BEARING
SHEAVES

BLAW-KNOX
BUCKETS

Sealed ball bearing sheaves in the lever arm reduce lost time and expense of bearing replacement, increase cable life and reduce friction, materially improving operating efficiency. This, and many other better features, that make BLAW-KNOX the "wise" buy in buckets are fully explained and illustrated in NEW CATALOG 1757. Send for your copy today.

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BLAW-KNOX BUCKETS

BLAW-KNOX BINS AND BATCHERS • ROAD FORMS • STREET FORMS • CONCRETE SPREADERS • ROAD FINISHERS • VIBRATORS

CONCRETE BUCKETS • AMMUNITION BUCKETS • TRUCK MIXERS • CONCRETE MACHINERY • CONCRETE CONTAINERS • TAMPING BUCKETS • CONCRETE FORMS

asphalt, and a 3-compartment storage bin with capacity for about two batches. It is constructed as a semi-trailer, and may be pulled by any standard truck tractor. A tandem axle is provided for the rear wheels. Feeding the triple elevator of the mixer unit is the bin and screening unit, which is full wheel mounted, and may be towed with any standard dump truck. The 3-deck, vibrating screen is mounted on a 25-ton, 3-compartment bin. The third unit is a standard dryer, mounted as a semi-trailer, and using the same tandem axle as the mixer.

Each unit is powered by its own gasoline engine mounted directly on the frame. The elevators on dryer and mixer fold up for transportation. An outfit of this kind possesses very special advantages where jobs are small and railroad facilities limited. Further information is available by writing the manufacturer or to R. & S. by referring to.....RS100

Snow Plow Repair Kit

Blackhawk Manufacturing Co., Milwaukee, Wis., has brought out a repair kit No. 19076 for hydraulic control units of their manufacture. This kit contains 62 replacement parts and five special tools necessary for the great majority of simple field repairs on Model BM-1 and P-4

For servicing the P60 series of pumps, a complete replace pump head is available. The P60.264A head is for the P60 pump, which has $\frac{3}{8}$ in. diameter pistons, and the P63.264A head is for the P63 pump; this latter has $1\frac{1}{16}$ in. diameter

pistons. Complete instructions for servicing are included in the repair kit. Write to manufacturer for further information or to R. & S. by referring to.....RS123

New Super-Paymaster

The SUPER-PAYMASTER, a $\frac{3}{4}$ yard combination shovel, dragline, crane and pull shovel, recently developed by the Lima Locomotive Works, Incorporated, Shovel



Super-Paymaster

and Crane Division, Lima, Ohio, is a contribution to the efficiency and profitable operation of the earth moving and material handling industry. Its design embodies the same time-tested features that made its predecessor, the PAYMASTER, so popular with its many users. When equipped as a clamshell or dragline, capacity depends upon length of boom and material to be handled. When equipped as a crane, it has a 13 ton capacity. As a shovel, it is equipped with an 18 ft. boom and 15 ft. dipper handle. It is fast with ample strength to give steady dependable service in all kinds of work. Many new features which are worth consideration are found in its design, for instance:

1. Proper balance is accomplished by placing the machinery and power plant to the extreme rear of the rotating frame.
2. Hook rollers relieve the center pintle of all digging shocks.
3. The machine will respond instantly to all control levers which are within easy reach and are of short easy throw.
4. Friction is reduced to a minimum by the use of anti-friction bearings.
5. Machinery supports are mounted on the one-piece steel cast rotating base with finished bolts.
6. The swing clutches are the internal expanding type, toggle operated, with housings 17 in. in diameter by 6 in. wide.

7. The crawler truck is strong and stable—modern welded construction being used throughout and equipped with a lock for locking both crawlers from the operator's position. The crawler treads are 22 in. wide, however, 30 in. treads can be furnished. Treads have six-point connections.

8. Independent boom hoist is fast and accurate.

9. The boom is of all-steel box type construction, electrically welded throughout. The dipper handle is a single seamless type, 7 in. in diameter, with a single rack welded the entire length of the handle.

10. The cab is equipped with a winter front which is housed in top of cab when not in use.

11. The power take-off consists of a multiple roller chain operating in a bath of oil.

12. Chain or cable crowd can be furnished. No chain or cable adjustments are necessary when working boom at various angles.

Converting the Super-Paymaster to any one of its uses can easily and quickly be made in the field by simply changing the front-end. Further information and literature is available through the manufacturer or by writing R. & S. by referring to.....RS102

New Paving Breaker

More powerful, lighter in weight, and incorporating the most recent advances in paving breaker design is the new medium weight paving breaker just announced by a well known pneumatic tool manufacturer.



"23" Paving Breaker

This paving breaker can be used where handling ease is the main requirement. It is designed for general demolition of all kinds—street and wall openings, asphalt cutting, digging, and odd jobs where only a single tool is needed. Despite the relative lighter weight, it has the hard hitting power necessary for sustained demolition on the biggest construction job. This paving breaker can also be fitted with a special head for driving spikes up to 12" long. Further information is available by writing R. & S. by referring to.....RS101

Quick Detachable Sheaves for V-Belt Drives

A new type of V-Belt driver sheave, designated as the Q-D quick detachable and quick demountable type, is announced by Worthington Pump and Machinery Corporation, Harrison, N. J., as a standard item in its Multi-V-Drive line. Extreme simplicity of construction is claimed, and suitability for any application where quick mounting of sheave to shaft, and dismounting from shaft, are desirable; for example,



RED says DANGER DIETZ LANTERNS BRING SAFETY

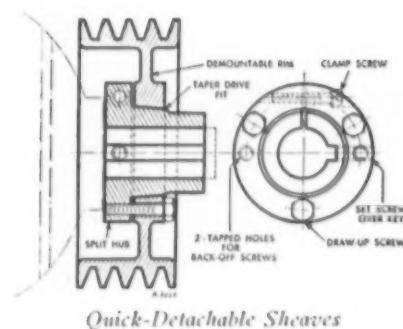
Bright lights without diminishment—no wind or rain can bring failure—that is why DIETZ LANTERNS are the standard warning beacons for safety on the highways of America.

The DIETZ "LITTLE GIANT" illustrated will burn throughout an entire weekend with plenty of fuel to spare. Write for catalog of DIETZ Lanterns and Road Torches.

Order thru your Mill
Supplies Distributor.

R. E. DIETZ COMPANY

1840 NEW YORK 1941
MAKERS OF LANTERNS FOR THE WORLD



Quick-Detachable Sheaves

on those classes of equipment where speed ratios must be changed to meet varying conditions. In general maintenance, it eliminates the necessity of a wheel puller to remove wheel or hub from shaft to get at the driving unit.

Each sheave unit consists of two parts, a longitudinally-split or clamp hub and a V-grooved rim. The hub is clamped to the shaft by means of a cap screw in its flange and is securely fastened by a standard keyway. A fit equal to a press fit, on shafts up to ten thousandths over-size or under-size, is provided. The rim is taper-fitted to the hub and is fastened with three draw bolts.

To remove the rim, the draw bolts are withdrawn and two of them are inserted in holes so tapped in the rim that the bolts act as jamb screws and bear against the hub, thus forcing the rim off the taper without disturbing the position of the hub. No pounding or prying is required to re-

move either the rim or the hub. With this equipment, it is claimed that the dangers of battered motor bearings, bent shafts, broken sheaves, and human injury are eliminated. Descriptive literature will be furnished upon request to the manufacturer or through ROADS AND STREETS by referring to RS-114.

"Flex-Plane" Improvements for 1941

The Flexible Road Joint Machine Co., Warren, Ohio, have announced that the following improvements will be in effect on all "Flex-Plane" equipment during 1941:

1. Two cutters, instead of one, will be standardized on joint installing machines—the first cutter to cut the groove, the second to reopen the groove.

2. Ribbon joint material has been improved to furnish a more pliable material.

3. Tapered screed wings will be continued as standard equipment on their finishing machines.

4. The 20 in. wide sectional screed has been improved to permit settings in the front section from zero to $\frac{1}{4}$ in. higher than the adjoining rear section. In case of dry material, this will effect a finish with the second section without an overrun.

5. Flex-Plane screeds have been improved to permit crown adjustments near the ends—no shims are required as this is now done with additional adjusting bolts. Literature on their products is available by request to the manufacturer or through R. & S. by referring to RS-116.

For reducing ROAD MACHINERY MAINTENANCE...



The
SELF-LOCKING NUTS
that can't be loosened by
vibration or hard service

... specify them on new equipment
and use them for replacement.

• Folder explaining the Elastic
Stop principle is worth writing for.

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Elastic Stop SELF-LOCKING NUTS

PENNSYLVANIA TURNPIKE is outlined with CATAPHOTES



Installed by Western Cataphote Corp., Toledo, O.

Cataphote Niteway Outliners are installed 100 feet apart, outside of pavement edge and on the center strip.

Cataphotes respond to auto headlight beams by reflecting a continuous line of light, indicating the contour of the road for miles ahead.

Cataphote Niteway Outliners were selected by the Pennsylvania Turnpike Commission as Road Delineators for their extra brilliance and long life.

Write for full information on

CATAPHOTE
REFLECTOR BUTTONS, SIGNS,
ROADSIDE DELINEATORS

WESTERN CATAPHOTE CORP.
WALL STREET TOLEDO, OHIO

New Kettle Models for White

The White Manufacturing Co., Elkhart, Ind., have announced the extension of their line of portable kettles for heating asphalt, road oil, and tar for highway repairing. Their new models are offered in capacities of 65, 110, 165, 220, and 300 gallons. All are equipped with oil burners, with double heat circulation and stack exhaust. Spray pumps, operated by hand or gasoline engine, are mounted on the rear of the kettles for complete accessibility. Either flexible metal or rubber steam hose carries hot material to a spray bar with insulated handle. Barrel hoist, thermometer, warming hood for an additional barrel and dual tires are accessories which can be furnished.



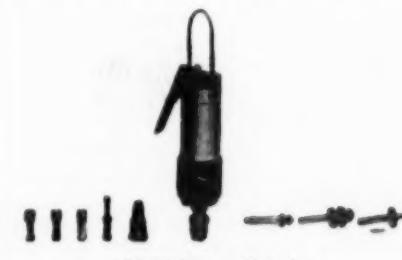
New Portable Kettle

Of the several innovations included on the new models, the "Fire-Proof" top is one of the more important features. This top is designed to combat serious fire hazards in heating inflammable material. Also the conventional hinged hatchways have been replaced with a top fully welded to the kettle, designed with a 16 in. dia. manhole with a lid. An automatic overflow at the rear of the kettle permits exit of gases or foaming material away from the oil burners. Literature is available upon request to the manufacturer or through R. & S. by referring to RS-117.

New 1 1/4-Pound "Multi-Vane" Grinder

A nationally known company has recently added a new "baby" air grinder to its line of pneumatic tools.

This tool, called the Size 00, weighs only 1 1/4 lbs. and operates at 20,000 r.p.m. at 90



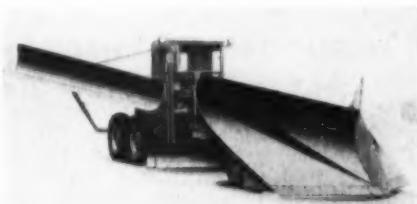
Multi-Vane Grinder

lbs. pressure. It is built to take 1½ in. diameter organic bonded or 1¼ in. diameter vitrified wheels. Also available are various sizes of collets to take mandrel mounted grinding wheels or small twist drills.

Although originally intended to be used as a die grinder for tool room and bench work, it is now being used by industry at large for light grinding jobs wherever metal must be removed from places that would otherwise be hard to reach. For further information and literature write R. & S. and refer to.....RS104

New "Caterpillar" Snow Plows

Newly designed snow plows for all models of "Caterpillar" motor graders are being shown by Caterpillar Tractor Co.,

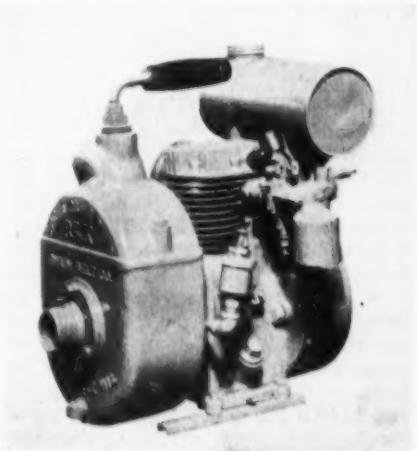


"Caterpillar" Snow Plow

Peoria, Ill. The new plows feature an alloy steel in the moldboards to give great strength in proportion to weight. Also featured are extensive welded reinforcements, and crank-type lifts, giving down pressure on the plows. Mast-type snow wings and reversible one-way plows for motor graders are also available. Literature is available by request to the manufacturer or through R. & S. by referring to.....RS105

New 3000 GPH Water Pump

A well known manufacturer announces the manufacture of a new junior lightweight, 3000 GPH centrifugal pump for water moving problems. The overall dimensions of 15¼" long by 11¾" wide by 15¾" high, combined with a weight of only 54 pounds, makes it possible to pick up this pump with suction and discharge hose still attached, and carry it from job to job in



"Rex Junior" Pump

the trunk compartment of an automobile.

This 1½" pump contains all the engineering features of the standard line of centrifugal pumps produced by them. It has a large semi-steel recirculating water chamber equipped with an aluminum cap and is powered by a dependable, single cylinder, air cooled engine of ¾ to one horsepower. The engine is equipped with an automatic governor that speeds up the motor when the pump catches its prime and starts to lift water. This eliminates the possibility of putting too much strain on the power unit at low speeds and assures economical performance.

This rugged little pump not only will reduce water moving cost, efficiently, but also reduce the man hour costs in handling it from one job to another. For further information and literature write ROADS AND STREETS and refer to.....RS103

New Koehring Trail-Dump

Koehring Company, Milwaukee, Wisconsin, has added another new size Trail-Dump to its line of hauling equipment. This latest model has a capacity of 12 cubic yards, adding another unit, for a total of three sizes, 8, 10 and 12 cubic yards. With the increased capacity, Koehring has increased the strength of the body, improved the "automatic hand" winding mechanism and made such other changes as were necessary for the increased load.



Koehring Trail Dump

The popular General Motors two cycle diesel engine furnishes steady and dependable power. Gasoline engine power is also available.

Approximately one year of field service on contractors' jobs, has placed this machine beyond the experimental state and it is now released for general sale. When writing R. & S. for literature refer to RS107

Huber Builds New Tandem Roller

The Huber Mfg. Company, Marion, Ohio, has recently placed on the market a streamlined variable weight tandem roller that is modern in every detail. This new Huber incorporates many important operating features. Among them are: variable weight; three speeds forward and reverse; dual controls for operating the machine from either side; automotive type construction; ease of operation; high frame clearance; easy hydraulic steering; anti-friction bearings at all strategic points; all moving parts fully accessible; full width

CHEAPER than wood in the long run

Always ready for action to build...

- Combined Curb and Gutter
- Straight or Battered Curbs
- Integral Curb
- Any shape of Curb Face
- Sidewalks, etc.

BLAW-KNOX STEEL FORMS

BLAW-KNOX DIVISION of Blaw-Knox Co., FARMERS BANK BLDG., PITTSBURGH, PA.

BLAW-KNOX

BLAW-KNOX BINS AND BATCHERS • ROAD FORMS • STREET FORMS • CONCRETE SPREADERS • TAMPING ROLLERS • VIBRATORS • CONCRETE BUCKETS • CLAMSHELL BUCKETS • TRUCK MIXERS • STRIPING MACHINES • TURNTABLES • ROAD FINISHERS • STEEL FORMS



Huber's New Tandem Roller

seat; large capacity, sturdily built water tank; and rust resisting sprinkling pipes.

The new Huber Variable Weight Tandem Roller is powered with a 6-cylinder Buda gasoline engine providing ample reserve to meet unforeseen emergencies. If Diesel power is preferred, it can be supplied on special order. Simplicity of operation, plenty of speed, maximum maneuverability, centralized control of every roller movement, low maintenance and all-round operating economy have been definitely achieved in this latest Huber development.

This latest addition makes a total of six sizes of Huber automotive type rollers, all equipped with electric starters. Literature is available by request to Huber Company or through R. & S. by referring to RS111

A New Ice Remover

A new highly concentrated ice remover has been introduced to the market by a

well known company. It is said it will melt its own weight of ice. The product is also used to thaw eave troughs, drains, etc.; this is accomplished by pouring a generous amount of the ice removing crystals directly into frozen area. The cost is small, and it is economical to use. The chemical composition of the ice remover is not injurious to concrete, brick, etc., and is clean to use as it does not leave a white deposit. Further information and literature are available through R. & S. by referring to RS106

attachable bucket. The boom is mounted on the rigid frame and can be raised or lowered by cables that uncoil from the winch. With the boom lowered, it swings the material bucket free from the tail of the truck. The bucket can then be lowered through its cable attachments to a desired depth, with a maximum of 30 feet below the ground line of the truck. Reaching for its load is the important feature of this equipment. It is stated to do the job economically and to accomplish the same results that ordinarily would require additional equipment. With the bucket removed this truck unit becomes a useful hoisting unit for laying pipe, handling castings, pulling piling, back-filling ditches, etc. A two page, two colored folder describing this equipment more fully, with specifications, is available upon request through ROADS AND STREETS by referring to RS108

New Crane Dump Truck

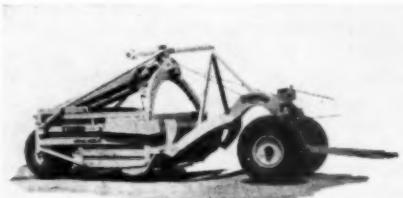
Uniting a hoisting boom to the dump truck is the achievement of equipment engineers of a nationally known engineering company in the creation of their new combination crane dump truck. Essentially this compact hauling equipment can be divided into four general parts—rigid frame, mechanically powered winch, boom and a de-



New Dump Truck

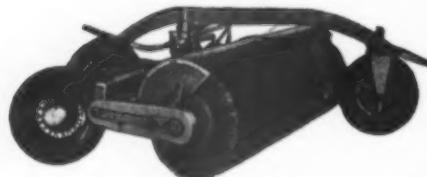
Model LP Carryall Replaces Old P

To give increased efficiency for stripping, road construction and similar earth-moving with scrapers of average size, R. G. LeTourneau, Inc., Peoria, Ill., has developed a new single bucket, cable controlled Carryall Scraper, the Model LP, replacing the Model P, for use behind D8 "Caterpillar" tractors. Struck capacity is 12.1 cubic yards, and heaped 15. New LeTourneau features include apron cable dead-ended for longer cable life; new apron design for increasing capacity, reducing overflow and facilitating loading by reducing friction; and a new overhead traveling sheave assembly which keeps dirt out of the sheaves and lengthens cable life. In addition to these innovations, the Model



Model LP Carryall

GRACE — 2-WAY AXLE DRIVEN SWEEPER



RAPID FIRE HEATER



● Grace 2-Way Axle Driven Sweeper—the modern traction driven sweeper that successfully meets every problem of any contractor.

● Rapid Fire Heater—A fast-pumping, fast-heat circulating heater that heats 10,000-gallon insulated cars at 50° per hour. Write for detailed information and prices.

W. E. GRACE MFG. CO. 6000 Holmes St.
DALLAS

BURCH LOW COST MAINTENANCE



The BURCH TRUK PATROL is the answer to speedy, efficient and economical road maintenance. A reversible blade with power hydraulic lift and pressure enables the blade to do more and better work and eliminates "chatter." The draft bar is equipped with a ball and socket joint which permits the blade frame to take the contour of the road. The blade is easily and quickly controlled from the truck cab by a power valve mounted near the operator.

Manufactured by

THE BURCH CORPORATION

Crestline, Ohio

Builders of Equipment for Fifty Years

LP incorporates positive ejection and regulated spread, controlled cutting, narrow 8 ft. 6 in. cutting edge, tailgate cable pull at load center, and box beam arc welded construction for great strength and light weight.

Designed for use behind a standard D8 tractor, this unit combines easy loading with large capacity. Its ability to load easily and efficiently without the aid of a pusher makes it an economical unit for use either singly or in fleets. Easier loading is due to the narrow cutting blade and a newly designed blade base, the narrow 8 ft. 6 in. width allowing greater drawbar pull to be applied per lineal foot of cutting edge.

In order to operate the LP Carryall under all types of conditions, provision has been made to equip the scraper with either four 13.50 x 20 tires or two 18.00 x 24s in the rear and, in the front, either two 13.50 x 20s or two 18.00 x 24s. Further details are available through the manufacturer or by writing R. & S., referring to RS110

WITH THE MANUFACTURERS

L. C. Allenbrand Succeeds G. E. Spain

Caterpillar Tractor Co. has announced the appointment of L. C. Allenbrand as manager of the company's sales development division. Mr. Allenbrand succeeds G. E. Spain, who has been promoted to general sales manager.

Mr. Allenbrand was born near King City, Missouri, and received his early training there. After attending the University of Missouri he went to work for the John Deere Plow Company of Kansas City in 1923. In April, 1931, he joined the Caterpillar Tractor Co. as a special representative in the general sales department, which ultimately carried his activities to the Doyle Tractor and Equipment Co., "Caterpillar" distributor at Visalia, California.

Early in 1934 he returned to Caterpillar Tractor Co. at the Peoria, Ill., factory as assistant manager of the sales training division. He has held that position until the present time. During recent years he organized and has conducted the company's program of sales meetings which are held at distributors' offices throughout the United States and Canada.

Pittsburgh Steel Company Appointments

Robert L. Glose has been appointed Sales Manager and Thomas C. Phillips, Dealer Sales Manager of the newly established Construction Products Division of Pittsburgh Steel Company, Pittsburgh, Pa. Mr. Glose has heretofore been Manager of Welded Fabric and Construction Products Sales for Pittsburgh Steel Company, and Mr. Phillips, who was associated with Pittsburgh Steel Company, has for the past 6 years been with Johns-Manville Corporation, New York.

The Construction Products Division of Pittsburgh Steel Company will have charge of the sales of all of the company's wire fabric construction products which include welded wire reinforcement for roads, streets, driveways, sidewalks, pools and reservoirs; for airport aprons and runways; for concrete pipe, sewers and culverts; for vaults, walls, floors and roofs; and the line of Pittsburgh Steeltex (wire reinforcement with integral paper backing) for plaster, stucco, stone and brick veneer and floors. Included also in the company's construction products are Pittsburgh Safety Highway Guard and Cable Guard.

All of these products have been widely distributed and are well known throughout their respective markets, and the company's present policy in placing the sale of these related products under a single responsible construction products division will be gratifying to the distributors and users of these products generally. The company's several district offices also will have sales representatives for these special products for more efficient service to the markets concerned.

Koppers Company Integrates

Stockholders of The Wood Preserving Corporation, a Koppers Company subsidiary, at a special meeting Dec. 11, 1940, voted to liquidate the corporation. Its business will be conducted as an operating and sales division of Koppers Company after Dec. 31, this year, it is announced by G. B. Shipley, board chairman, and W. F. Munnikhuyzen, president of the corporation.

It was stated that this action was taken in order to simplify the Koppers corporate structure and to further integrate operating and sales activities with other divisions of Koppers Company. It also stated that no changes will be made in the general management of Wood Preserving plants and that operations will be continued as at present.

Charles J. O'Brien Joins Giles & Ransome

Charles J. O'Brien, formerly service and sales engineer with the Blaw-Knox Co., in the eastern part of the United States, is now a member of the sales organization of Giles & Ransome, Equipment Dealers, Philadelphia, Pa.

Frank B. Hamerly Dies

Frank B. Hamerly of Aurora, vice-president of the Independent Pneumatic Tool Company of Chicago, died Nov. 27th of a heart attack while inspecting the company's plant at Los Angeles, Cal. Mr.

Hamerly was 53 years old. He had lived in Aurora, where the company has a plant, for the last 28 years. His home was at 82 South 4th Street in the suburb. He was the husband of Mrs. Mable Hamerly and the father of Joseph Hamerly and Mrs. Harry Callahan.

Henry M. Hale Enters Partnership With John R. Taylor

Henry M. Hale, Eastern Sales Manager of Caterpillar Tractor Co. at Peoria, Illinois, has announced his resignation from that office to enter into partnership with John R. Taylor as the Taylor-Hale Machinery Co. of Memphis, Tenn. From its headquarters in Memphis, the newly formed company will handle sales and service of "Caterpillar" products in an extensive southern area.

Mr. Taylor, with whom Mr. Hale will be associated, is also a former employee of Caterpillar Tractor Co. He served in several sales promotional and sales administrative capacities before leaving the company to become general manager of the Memphis distributorship.

The vacancy created by Mr. Hale's resignation from the company is being filled by the advancement of George Rinck from assistant eastern sales manager to eastern sales manager. Mr. Rinck's employment with "Caterpillar" has been in several Sales Department capacities.

Kenneth ("Hy") Cox is Mr. Rinck's successor as Assistant Eastern Sales Manager.

They pay for themselves in savings.

BLAW-KNOX BULK CEMENT PLANTS have everything

SHIPPED IMMEDIATELY FROM STOCK

A complete job ready to go to work. They include:

- Cement storage bins in a complete range of capacities, both portable and knockdown type, including steel roof for the storage bin.
- Weighing batchers for cement, of any size required, equipped with either beam scales or springless dial scales—manual or automatic types.
- Conveying equipment for elevating cement into storage bins with necessary unloading equipment for receiving cement in hopper bottom cars, box cars, or from truck delivery.
- Power unit and drive for conveying equipment, either gasoline or electric.

Interesting Blaw-Knox Bulk Cement Plants are fully described in Catalog No. 1566. Write for a copy.

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"BERG" HI-WAY SURFACERS



Model H-8

MODEL H-8
WITHOUT CLUTCH

MODEL H-10
WITH CLUTCH

The above models are one-man, gasoline driven machines, for surfacing concrete roads, streets, floors and other concrete paving.

The Power Take-Off is an EXCLUSIVE FEATURE, permitting attachment of "BERG" flexible shaft equipment, for surfacing walls, bridges, culverts, etc. Pioneers in Concrete Surfacing Machinery.

Write Dept. C

THE CONCRETE SURFACING MACHINERY CO.
CINCINNATI, OHIO

NEW TRADE LITERATURE

Bitumen for Better Tar Roads is a vest-pocket companion for users of tar products, prepared by the Reilly Tar & Chemical Corporation, Merchants Bank Building, Indianapolis, Ind. This little book, which has an eggshell leather binding, contains 42 pages of useful information for better tar roads. In it you will find road tar specifications, quantity tabulations for road materials, road tar conversion tables, weights and measures, and etc. It also provides many single lined and graphic ruled pages for you to jot down notes for future reference. One can be obtained by request.

How To Choose a Slide Rule is the title of a booklet prepared by Don Herold for Keuffel & Esser & Co. It contains 24 pages, has 26 illustrations, and is printed in 2 colors. This humorous publication explains for the first time the difference between various types of slide rules available, in straight forward, salty language. Although written primarily for students in engineering colleges, the booklet contains slide rule information of interest to the entire engineering profession. Copies may be obtained upon request by writing to ROADS AND STREETS.

Black Top Distributor Slide Rule.—With the announcement of the "Computator," a new computing slide rule for operators of Etnyre "Black Topper" distributors, control of the machines has become so simple that "even a schoolboy can operate it, according to an announcement by executives of E. D. Etnyre & Co., Oregon, Illinois. Not only has operation been simplified, but guesswork on the part of the operator has been removed, resulting in accurate control of every phase of distribution.

For the convenience of the operator and to reduce the overall size of the slide rule, the "Computator" has tables on both sides. By following the instruction sheet and using the specially designed slides, it is possible to quickly determine the Bitumeter or Tachometer settings for spray bar lengths of from 3 ft. to 30 ft., the material required for application up to 3 gals. per square yard, and the solution of any multiplication, division or percentage problem.

Printed on heavy, toughened cardboard . . . precision die-cut for accuracy . . . hot-press laminated with heavy cellophane . . . the "Computator" is not only durable, but highly resistant to finger smudges. Deposits on the smooth surface can be quickly removed with a damp cloth. Copies of the "Computator" may be obtained for \$1.00 each by writing direct to the company's main office at Oregon, Illinois.

Dredge Buckets.—For the dredging operator Amsco has prepared a bulletin, No. 1140, to describe and illustrate their rivetless lip dredge buckets. This two-page folder, printed in 2 colors, itemizes 12 points of superiority of their product in a clear and concise manner. Copies are available upon request through ROADS AND STREETS.

Reliance— CRUSHING SCREENING and WASHING UNITS

• UP TO 2000 TONS A DAY •

Crushers	Bins	Drag-Lines
Elevators	Pulverizers	"GAYCO"
Sweepers	Feeders	Centrifugal
Screens	Spreaders	Kettles
Wash Boxes	Conveyors	Air Separators

UNIVERSAL ROAD MACHINERY CO.
Kingston, N. Y.

Canadian Representatives: F. H. Hopkins & Co., Ltd.
340 Canada Cement Co., Montreal, Que., Can.



For Better Roads, put a WORKMAN Machine on the job. 3 sizes:
THE GENERAL • THE SUPER
THE MASTER

YORK MODERN CORPORATION
UNADILLA, NEW YORK

NOVO BREAKER

PAVEMENT

Demolishing
Trimming &
Cutting



BREAKING

The results obtained with the Novo Breaker in breaking up pavements, bridge floors, drives, curbs, etc., have proved beyond a doubt that here is the fastest, cheapest breaking method.

CUTTING

Hammer equipped with shearing knife is used for trench work, cutting without breakback in reinforced concrete. Also used in frost & trimming.

COSTS

Let us tell you the surprisingly low cost figure at which pavements can be broken by this method. It mounts on your truck. Send for information.

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NOVO ENGINE COMPANY
LANSING, MICHIGAN

ASPHALT PLANTS AND PAVING CONTRACTORS

BE PREPARED for airport, road, defense construction and maintenance projects by manufacturing asphalt emulsion stabilizer for your own mixing plant or for resale.

PRODUCE HEADLEY Emulsified ASPHALTS

*Slow Break—Stabilizer—Cold Patch
Quick Break Penetration*

We furnish simple equipment and manufacturing assistance.

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COMFORT IN CHICAGO

231-coil inner-spring
mattresses, downy
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ventilation assures
your comfort.

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\$ 2 WITH
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